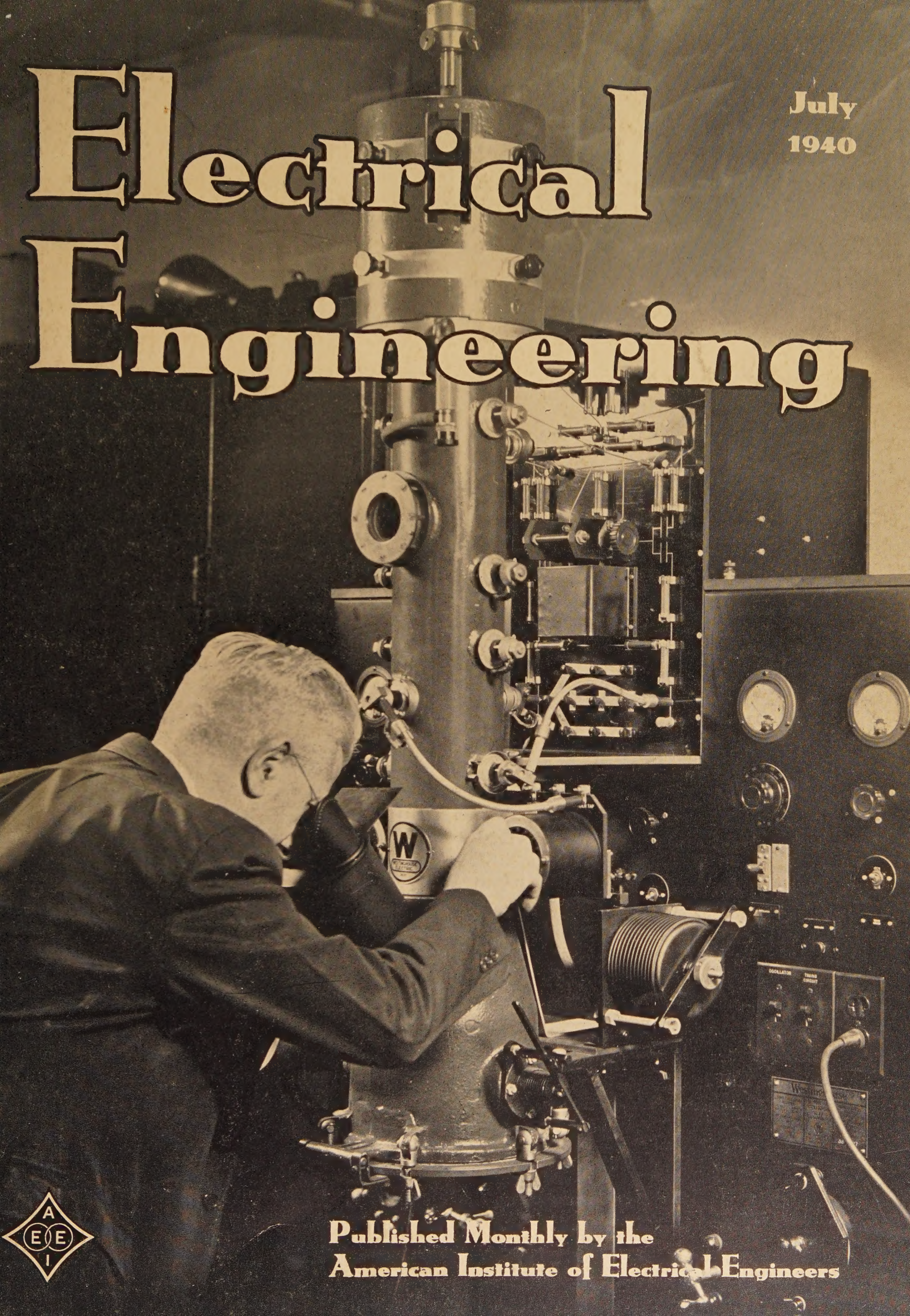
Electrical Engineering

July
1940



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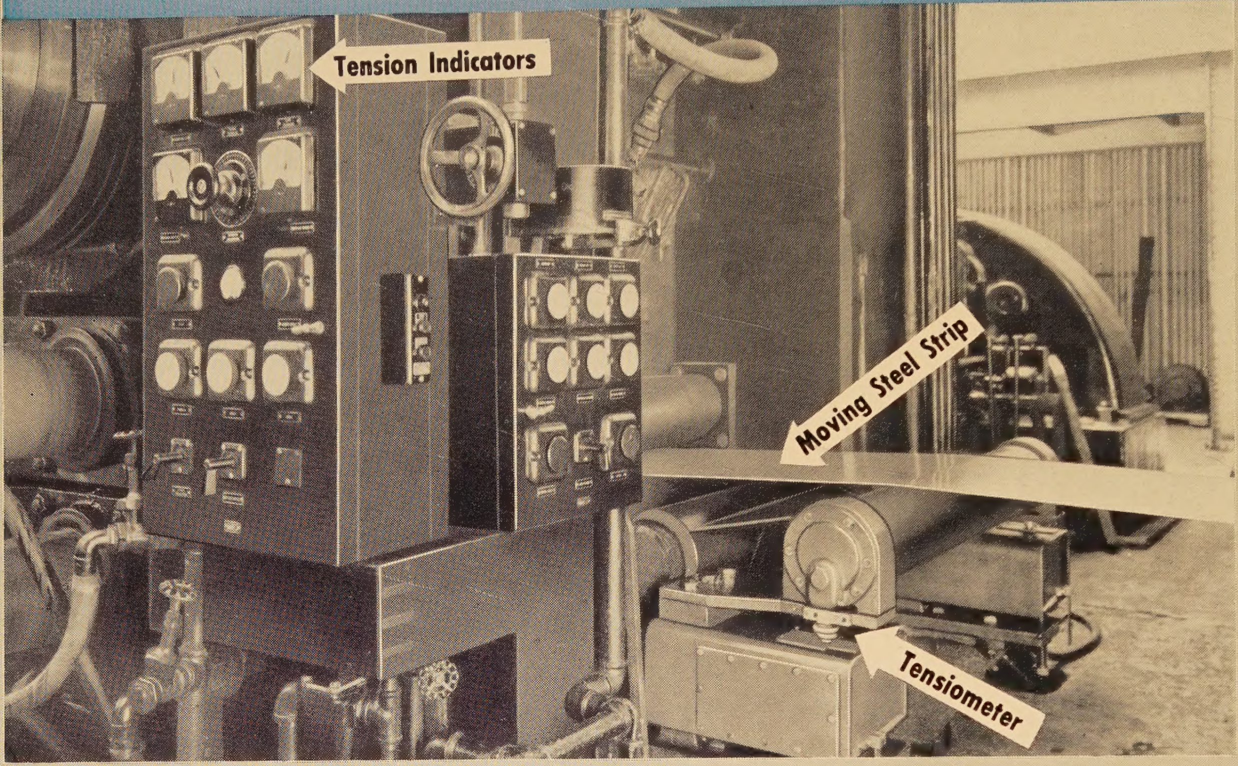
To Measure—STRIP TENSION

ELECTRICALLY



PICTURE in your mind a strip of steel moving 2000 feet per minute—nearly 23 miles an hour—through successive pairs of giant rollers that press it into a smooth thin sheet. Then picture this rapidly moving strip being subjected to varying tensions—pulling, stretching forces in magnitudes up to 150,000 pounds.

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It was to solve this important measurement problem that G-E engineers developed the tensiometer, an instrument that gives continuous indications of the tension in strip steel during the rolling process. As a result, tension can be controlled, and a better, more uniform product is produced at a lower cost.

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Whenever you have a problem that involves measurement, remember General Electric, Schenectady, N. Y.

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

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602-12

Electrical Engineering

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for July 1940—

The Cover: Cathode-ray oscillograph developed for the new high-voltage laboratory of the National Bureau of Standards at Washington, D. C.

Photo courtesy of Westinghouse

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¶ Correspondence is invited on all controversial matters.

High Lights • •

Impulse Strength. Cable insulation often has been damaged by lightning, but little information regarding its impulse strength has been available. Some tests on oil-treated paper-insulated cables over the range of insulation thickness from 0.187 to 0.600 inch, including several grades or densities of paper, indicate higher breakdown values for the denser papers, but the average breakdown stress values found were approximately 1,600–1,700 volts per mil (*Transactions pages 389–94*). Other tests with impulse voltages on rubber and varnished-cambric insulation indicate strengths for rubber of from 700 to 1,600 volts per mil, depending upon the compound, and for varnished cambric and oil-impregnated paper about 1,000 and 2,000 volts per mil respectively. These values are about from two to four times the 60-cycle strength of rubber, and three to four times that of cambric and paper (*Transactions pages 394–402*).

The Ionosphere. Were it not for the ionosphere, the electrically conducting envelope surrounding the earth at an altitude of several hundred miles above its surface, radio as we know it today would be nonexistent. Chief agency in producing the ionosphere, which consists of a mixture of electrified and nonelectrified gases, is the intense ultraviolet radiation from the sun which if not exhausted in forming of the ionosphere would probably be intense enough at the earth's surface to be deadly. The lethal short waves of the sun are spent, therefore, not harmlessly merely but usefully, in erecting the barrier to keep the long waves of the wireless pent up within the lower atmosphere where they can be of value (*pages 272–83*).

Electricity in the Navy. Three outstanding electrical accomplishments in the United States Navy in recent years have been: (1) the introduction of electric propulsion on surface ships; (2) the use of alternating current in place of direct current; and (3) the development of Diesel d-c electric drive on submarines, according to a commanding officer in the Navy, who says that "the Navy is keenly aware of the future development of engineering in all phases and is continuously pushing new ideas and developments in order to increase the military effectiveness of the ships" (*pages 267–70*).

Power for Airplanes. The electric-power loads of airplanes are growing rapidly to meet the demands of increases in size, speed, and flying range. Present-day applications require large generators operating at relatively high voltages to assure economic installations. Units are designed to secure minimum weight for a specific flight time, and may be of either of two general systems —a 110-volt 400-cycle three-phase system for large aircraft, or a 24-volt d-c system for lighter types of planes which have small motor loads (*Transactions pages 385–9*).

Fluorescent Lighting. After two years in service, the fluorescent lamp no longer can be considered a lighting novelty; it has proved to be a practical and adaptable light source, unusually efficient in the production of both colored and daylight illumination, without excessive radiant heat. It is thought that this new light source will not supplant all other sources, but instead will supplement them, giving the illuminating engineer a further means of creating the high levels of interior illumination needed for eyesight conservation (*pages 261–6*).

Kilowatt-Hour Measurement. The accuracy with which electric energy is metered is dependent upon the apparent measured value of the kilowatt-hour used. An improved system for maintaining the value of the kilowatt-hour to be used primarily for the calibrating and checking of portable standard watt-hour meters is composed of three precision rotating standards, and is capable of maintaining a high degree of accuracy (*Transactions pages 412–16*).

Mercury Condensation. In mercury-arc tubes, vapor continuously evolved from the mercury-pool cathode is condensed on cooled surfaces; the efficiency of condensation has been found experimentally to be quite low. Nickel surfaces condense the vapor several times as efficiently as steel, and a great improvement in efficiency is obtained by positive-ion bombardment of the condenser (*Transactions pages 381–4*).

Power Preparedness. In a national emergency calling for more power, if the power industry does not supply the power, the Government will, says the head of a middle western power company, who states that the power companies have the engineering ability and financial resources, and a habit and tradition of growth that would enable them to take such an assignment completely in their stride (*pages 270–1*).

Inductive Co-ordination. Electromagnetic induction from a power system may cause disturbances on a nearby communication system, the avoidance of which is a problem of co-ordination. Developments during the past decade have affected somewhat the problem of low-frequency induction resulting from power-system ground faults (*Transactions pages 403–12*).

High-Frequency Engineering. To push forward the understanding of high-frequency theory requires that the engineer possess the analytical tools and the ability to apply the tools to the solution of practical problems; because colleges rarely provide the required training, a postcollege course has been established in industry (*Transactions pages 374–80*).

Directors Report. Included in full in this issue is the annual report of the AIEE board of directors to the Institute membership for the fiscal year ending April 30, 1940. It contains brief reports of the activities of the various committees and the usual financial tabulations (*pages 290–303*).

New AIEE Officers. Among other items of business at the annual meeting of the AIEE held during the summer convention just concluded at Swampscott, Mass., was the announcement of new officers elected for the administrative year beginning August 1, 1940 (*page 289*).

Pacific-Coast Convention. Southern California and the Pacific Southwest offer many attractive possibilities for combined vacation and Pacific-Coast-convention trips; the convention inspection-trips committee has offered assistance in planning vacation schedules (*pages 288–9*).

Traction Motors. The introduction of lightweight high-speed motors to electric transportation has modified the technique of selecting motors for specific applications, which is based fundamentally on the speed-time curve (*Transactions pages 369–74*).

New AIEE Committee. Establishment of a new technical committee on domestic and commercial applications was one of the many actions taken at the May 24 meeting of the AIEE board of directors (*pages 303–04*).

Standardization. A statement of policy concerning AIEE standardization activities has been prepared and approved by the Institute's standards committee and was recently approved by the board of directors (*page 306*).

Coming Soon. Among special articles and technical papers now undergoing preparation for early publication are: an article on television, which surveys its history, discusses operating principles, and endeavors to answer a number of questions frequently asked, by G. R. Town (M'37); a paper on water solution in high-voltage dielectric liquids by F. M. Clark (A'24); a paper describing electric couplings by M. R. Lory, L. A. Kilgore (M'37), and R. A. Baudry; a paper on a harmonic theory of noise in induction motors by Wayne J. Morrill (M'35); a paper on the control of inductive interference to telegraph systems by J. W. Milnor (F'30); a paper on induction-motor characteristics at high slip by Theodore H. Morgan (F'39), William E. Brown (A'39), and Arthur J. Schumer (A'39); a paper discussing lightning protection on distribution systems by R. C. Bergvall (A'24) and Edward Beck (M'35); and a paper describing a transient analysis of symmetrical networks by the method of symmetrical components by Louis A. Pipes (A'37).

Subscriptions—$12 per year to United States, Mexico, Cuba, Porto Rico, Hawaii, Philippine Islands, Central and South America, Haiti, Spain, Spanish Colonies; $13 to Canada; $14 elsewhere. Single copy $1.50. ¶ Address changes must be received by the 15th of the month to be effective with the succeeding issue. Copies undelivered because of incorrect address cannot be replaced without charge. ¶ ELECTRICAL ENGINEERING is indexed annually by the Institute, weekly and monthly by *Engineering Index*, and monthly by *Industrial Arts Index;* abstracted monthly by *Science Abstracts* (London). Copyright 1940 by the American Institute of Electrical Engineers. Printed in the United States of America. Number of copies this issue 21,800.

Fluorescent Lighting After Two Years

OSCAR P. CLEAVER
ASSOCIATE AIEE

After two years in service, the fluorescent lamp has definitely established itself as a new tool for the illumination engineer that will supplement, but not supplant, other light sources

NEW in theory, design, and appearance, the fluorescent lamp was introduced some two years ago to the public and the illuminating-engineering profession at almost the same instant, giving the latter little time to study and prepare essential data before the former began to insist upon its application to every lighting field. The past two years, therefore, have been a period of catching up—of constant improvement in the lamp and its auxiliary equipment, and of rapid assembling of data on its performance and its limitations as a practical and economical light source.

How well the fluorescent lamp has measured up to the demands made upon it—its steady improvement, its dependability in service, its ability satisfactorily to meet modern lighting requirements—is reviewed in this article to provide a brief record of the unusual progress made in fluorescent lighting in so short a time.

The fluorescent lamp has not changed in theory since its introduction commercially, yet the present lamp is not the same lamp of two years ago. It has increased in life span 150 per cent in this time and its efficiency has been improved phenomenally when judged by standards established by incandescent lamps. The summary in table I of the increases in efficiency indicates the suitability of the adjective "phenomenal" in describing what has occurred since March 1939. Improvements in both life and efficiency are primarily due to better manufacturing technique and to research in phosphors leading to greater purification and better mixing.

Lamp life, however, is materially affected by the frequency of starting, because of the effect on the electrodes of the momentary high starting voltage. If lamps are started once or twice a minute, for example, the life will be greatly shortened. However, if lamps are turned on and permitted to burn continuously, the useful life may well exceed 2,500 hours. These two major improvements—longer life and high efficiency—have had considerable effect upon installation costs and, in a measure, may explain the rapidly increasing number of lighting fields wherein the fluorescent lamp is finding economical as well as logical application.

NEW LAMP SIZES AND COLORS

The introduction of the new 48-inch 40-watt fluorescent lamp with a tube diameter of $1^1/_2$ inches also has given stimulus to new applications. This longer tube requires less investment in sockets and auxiliaries per foot of tube and has a slightly higher efficiency, characteristic of the longer tubes. As yet, the 40-watt lamp is available only in the daylight and "new" white colors.

"New," as applied to the present white color, is entirely justified since experience with the former "warm" white indicated that it was much too pink when seeing and not decoration was the main lighting objective. The "new" white has a color temperature of 3,500 degrees Kelvin, as compared with the 2,800 degrees of the old warm white and 6,500 degrees of the daylight color. A result of this change has been the rapid shift in favor to the new white, which is inherently more efficient than the daylight lamp. Two years' experience with the other colors—red, gold, blue, pink, green, and daylight—has justified continuing them without change. Commercially, these colors have met most application requirements.

Of limited application are other fluorescent lamps that have been developed since the first one made its commercial appearance. Of interest is the 58- by $1^1/_4$-inch fluorescent-coated tube designed to operate on an a-c circuit with a rectifying auxiliary, thereby producing nonstroboscopic light at an efficiency of approximately 50 lumens per watt. Two colors are available in lamps of this type: (1) a blue-white, and (2) a white (called "industrial white") having a color temperature of approximately 8,000 degrees Kelvin. The lamp plus the rectifying auxiliary are rated at 100 watts, and its major field of application is industrial lighting.

Confined to special photographic lighting entirely are the two very small four-watt six-inch and six-watt nine-inch fluorescent lamps designed with oval-shaped tubes and special pin-type bases. Their operating characteristics are similar to those of the standard fluorescent lamps, but they require auxiliaries designed especially for them.

FLUORESCENT-LAMP AUXILIARIES ARE IMPROVED

The earliest auxiliaries really consisted of two parts in a single case: (1) a choke to limit the current to the designed value of the lamp; and (2) an automatic switch which, on starting, first closes the electrode circuit and then abruptly breaks it in order to induce a high voltage across the electrodes for starting the arc discharge.

The design of the choke presented no great problem, but the design of a switch proved to be something more difficult because it must have moving parts, and the limitations imposed on its size were rather drastic. For a time,

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Oscar P. Cleaver is head of the illumination section of the commercial engineering department, lamp division, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.; he also is chairman of the illumination group of the AIEE New York Section.

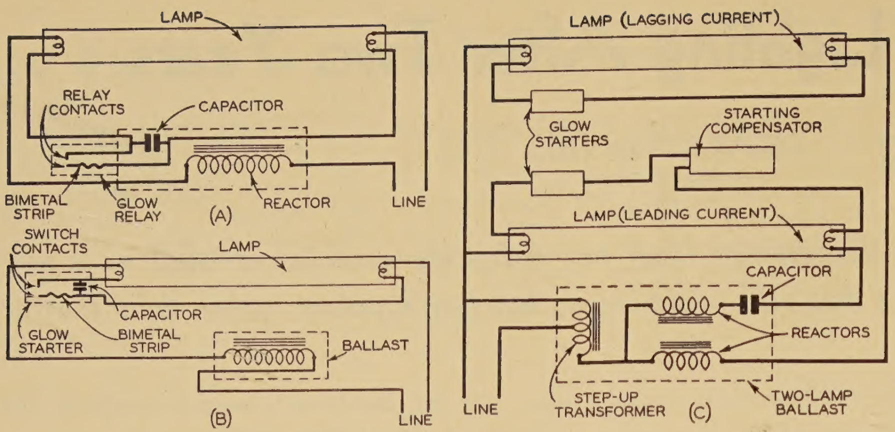

Figure 1. Circuit diagrams showing essential parts of new fluorescent-lamp controls using the glow switch for starting: (A) single-lamp type with glow switch in the end of the auxiliary case; (B) separate-ballast type with glow switch in lamp holder; (C) two-lamp type for high-power-factor operation with glow switch in lamp holder

Figure 2 (below). Lamp holder and glowswitch combination; cut-away view of switch container shows component parts

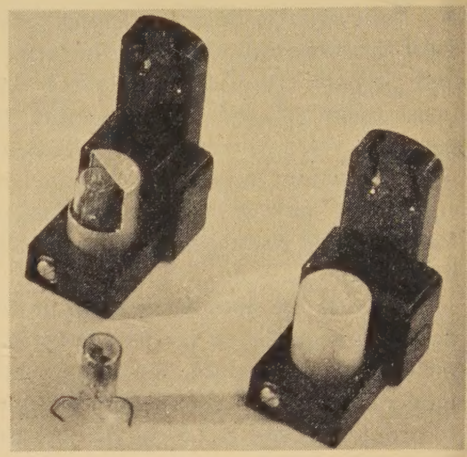

Table I. Increases in the Efficiency of Fluorescent Lamps Since March 1939

Length of Lamp (Inches)	Diameter of Lamp (Inches)	Color	Per Cent Increase
18	1	Daylight	10
		White (new)	30
		Gold	39
		Blue	15
36	1	Daylight	17
		White (new)	37
		Pink	5
		Blue	20
		Green	7
48	$1^1/_2$	Daylight	28
		White (new)	51

either a thermal switch operating on the principle of the expansion and contraction of a bimetallic strip when heated and cooled, or a magnetic switch similar to the "door bell" type of magnetic contactor, were encased with the choke and permanently sealed. The switch proved to be the element of the auxiliary most likely to become inoperative, and it was soon apparent that the separation of the switch and choke would prove to be a distinct operating advantage. The latest auxiliaries have been designed to give interchangeability and accessibility to the starter, which also has undergone some improvement leading to more positive operation with constant time lag regardless of the frequency of starting.

Consider now the changes in the auxiliaries. One design has the new switch inserted in the end of the auxiliary case (figure 1*A*). It therefore can be removed readily, provided the auxiliary itself is readily accessible—which, of course, it rarely ever is since it is likely to be sealed in a fixture or wiring channel. To take care of such situations, the latest improvement consists of casing the choke separately (now called a ballast) and designing the lamp socket to contain the starter switch in such a way that it is directly beneath the end of the lamp; the switch thus is concealed by the lamp, yet is as readily accessible for replacement as the lamp (figure 1*B*).

The new type of starting switch differs from the former type of thermal switch in that the heat required to affect the bimetallic strip now is generated by an electrical glow discharge replacing the former method of heating by an incandescent wire. As a consequence, the new switch is called a glow switch and has the excellent characteristic of being disconnected electrically when not actually in the process of starting the lamp. In practice, the small glass bulb containing the bimetallic strip and gas is enclosed in a cylindrical metal container together with a small capacitor across the switch terminals to reduce radio interference when starting (figure 2).

Along with the separation of choke and starter switch has come another innovation in auxiliary design which was introduced primarily to satisfy demands for higher power factors and less flicker in fluorescent installations without increasing installation costs. These new ballasts, designed for two-lamp operation (figure 1*C*), consist of a choke for one lamp and a choke and a capacitor for the other, both housed in a single case. The inductance and capacitance is such that the power factor of this combination is well over 90 per cent, closely approaching unity in most cases. These new twin ballasts are known commercially as two-lamp ballasts and are available for all sizes of fluorescent lamps of standard design. They, of course, must be operated by glow switches contained in one of the sockets of each lamp. Such a circuit may require a third ballast in series with the lamp operated with the capacitor, as the current for starting this lamp may be insufficient to heat the electrodes properly before the switch functions. The extra inductance in the starting circuit adjusts this condition, and is automatically switched out when the switch operates to start the arc discharge. Fortunately, this ballast is small and relatively inexpensive, and future developments may eliminate it entirely.

The use of two-lamp ballasts results in reduced flicker also, since one lamp is operating at a leading power factor and the other at a lagging power factor, the two being about 115 degrees out of phase. It has been determined that with this type of ballast and lamps close together, the resultant illumination from daylight or white lamps has slightly more flicker than that experienced with an incandescent lamp of 40-watt size on 60-cycle current.

Where odd numbers of lamps or single lamps are used, either high-power-factor single-lamp auxiliaries or special

Table II. Essential Technical Data on Fluorescent Lamps

*Watts (nominal—lamp only)	15	15	20	30	40
Tube	T-8	T-12	T-12	T-8	T-12
Nominal length (inches)	18	18	24	36	48
Approximate lamp amperes	0.30	0.33	0.35	0.33	0.42
Approximate lamp volts	56	48	62	103	108
Maximum over-all length (inches)	17$^{25}/_{32}$	17$^{25}/_{32}$	23$^{25}/_{32}$	35$^{25}/_{32}$	47$^{25}/_{32}$
Rated average laboratory life (hours)	2,500	2,500	2,500	2,500	2,500
Burning position	Any	Any	Any	Any	Any

* For total watts add wattage loss in auxiliary.

Lamps must be operated with special controls or ballasts designed to furnish the necessary starting voltage and maintain the proper operating current. Standard auxiliaries are available for operation on regular lighting circuits. All lamps listed have medium bipin bases.

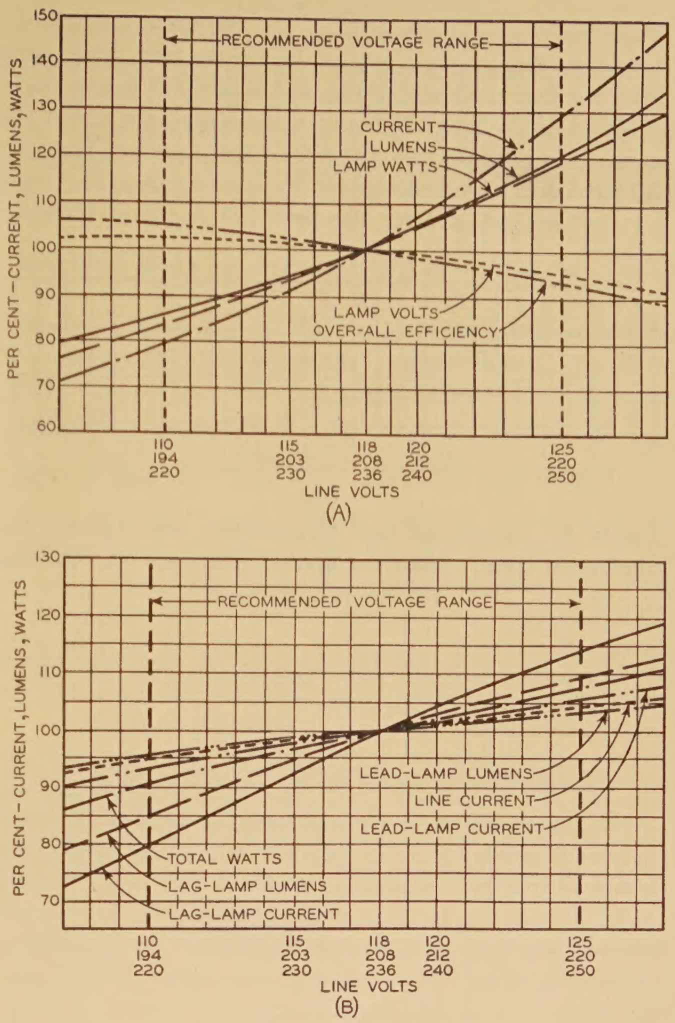

Figure 3. Curves indicating operating characteristics of fluorescent lamps when operated on (A) thermal-type auxiliaries; and (B) two-lamp ballasts. These curves vary slightly from the above when magnetic auxiliaries are used

capacitors to correct power factors to 80 per cent or above are available in sizes small enough to fit in standard wiring channels. This method, however, increases installation costs, while the two-lamp ballast adds no extra expense when used with the higher-wattage lamps. The over-all wattage loss in the latter auxiliary is about half what it would be if the former-type single auxiliaries for each lamp were used (see table IV). With such corrective equipment readily available, there is no longer any need for not having the advantages of high-power-factor installations in which the full wiring capacity can be utilized effectively.

Operation on direct current has been infrequent and has not been encouraged by lamp manufacturers; however, some notable installations have been made and equipment has been designed for such operation. In such instances, the regular type of ballasts and starter switches must be provided to supply the inductive kick for starting, in addition to a small resistance to control the current to the value required by the lamp. Since as much wattage is dissipated as heat in the resistance as is required for the lamp, no efficiency advantage over incandescent lamps is realized in such installations

CHARACTERISTICS OF THE FLUORESCENT LAMP IN OPERATION

The fluorescent lamp cannot be force-tested as can incandescent lamps, and its relatively long normal life has made it impossible to gather essential data on lamp performance as hurriedly as the application engineer might desire. After the experience of two years in operation, however, covering some 2$^1/_2$ million lamps, such essential and authentic data are now available (figures 3*A* and 3*B*). In many ways, the performance of fluorescent lamps differs from that of incandescent lamps, which doubtless will cause some reorientation of traditional thinking on the part of the engineer and the public as well.

For example, it has been customary in the past to assume that lamp life is longer when the supply voltage is less than the rated lamp voltage, and shorter when the opposite occurs. This is true for incandescent lamps, but not for fluorescent lamps. Variations in voltage, up or down from the recommended range of 110 to 125 (220 to 250) volts, apparently shorten lamp life. Lowering the voltage causes the electrodes to operate too cool and the electronic bombardment to become excessive, while raising the voltage increases the dissipation of the active material on the electrodes.

The life of a lamp perhaps is affected more by frequency of starting than by any voltage changes ordinarily encountered in service. Starting causes a momentarily high voltage drop at the electrodes which forces the active material to sputter rapidly, resulting in the gradual formation during life of a dark ring around the end of the lamp at each electrode. This same dark ring may be also a normal indication of the end of useful life, provided it does not occur too rapidly. Whether caused from normal or abnormal circuit conditions, the end results are the same: The voltage necessary for starting is increased and usually exceeds the available supply, causing the lamp to flash momentarily as the starter acts, but the arc never is established again. A new lamp is required.

The fluorescent lamp is somewhat similar to the incandescent lamp, however, with respect to the effect of voltage on light output. Overvoltage or undervoltage burning will raise or lower its output, respectively, about 1 to 2$^1/_2$ per cent (depending on type of choke used) for every 1 per cent voltage variation (figures 3*A* and 3*B*). Old age also takes its toll of lumens as a result of the evaporation of electrode material and of the effect of mercury on the fluorescent coating, both causing gradual darkening of the tube and its attendant light absorption. In the fluorescent lamp, however, this gradual process begins to take place only after the first 100 hours of life, as the curve in figure 4 indicates. For the first 100 hours, the darkening is about the same as is produced by the next 1,000 hours of burning. All published lumen ratings for fluorescent lamps are based on readings taken after the first 100 hours of burning.

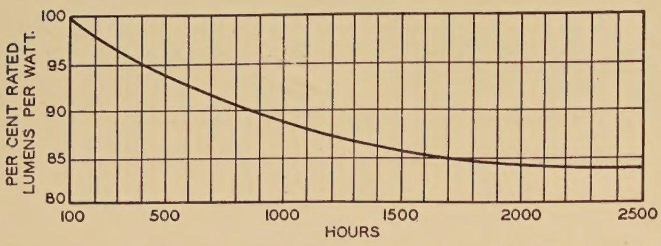

Figure 4. Lumens-per-watt depreciation with life for the fluorescent lamp. Note the gradual reduction after the first 100 hours of burning

Figure 4 indicates that the depreciation after this initial burning period is about 10 to 20 per cent at the end of the rated 2,500 hours, varying with the different colors.

EFFECT OF SURROUNDING TEMPERATURES

No consideration of the surrounding air temperatures has been necessary with incandescent lamps unless the temperatures were so great as to affect the basing cement or to destroy the metallic or glass parts of the lamp; but surrounding temperatures are important in fluorescent lighting because, in a measure, they control tube temperatures and this may have a decided effect on the lumen output of the lamps. The best tube temperature for acceptable performance ranges from about 100 to 120 degrees Fahrenheit; for every one-degree drop below this range there is a one-per-cent decrease in light output. It is well to emphasize the fact that these values apply only to tube temperatures, not to surrounding air-temperature conditions. Contrary to the general belief among the uninformed, the lamp is not a cool one to the touch even though it does deliver less radiant heat per foot-candle than other sources. Hence, if protected from cold air currents by shields or enclosing glass fixtures, it will generate enough heat to make possible its use out-of-doors in cold weather without too great a reduction in light output. This reduction may range from 30 per cent at zero with the lamp enclosed, to as much as 95 per cent in a strong draft with the lamp exposed.

The fluorescent lamp has proved unusually impervious to shock and vibration even in applications where conditions are severe. Its colors are true and can be matched in manufacture; variations in voltage and length of life cause little change in them. In fact, these new lamps have proved serviceable for most normal lighting conditions in modern illuminating engineering.

ECONOMICS OF FLUORESCENT LIGHTING

From the time of its commercial introduction, the new fluorescent lamp has captured the fancy of the man on the street, not alone because of its new appearance and new colors, but because he was told that it was the most efficient source of light available and that it was the nearest approach to "cold" light yet devised in a practical form. High efficiency suggested reduced lighting cost, and cold light greater personal comfort.

Too often ignored, however, was the fact that the cost of energy is only one of many factors that must be considered in determining the cost of lighting. Actually, the cost of equipment, wiring, and lamps often far overbalance any saving in energy costs in fluorescent lighting. After all, the lamp is a low-wattage source, with many required to produce the illumination levels necessary for eyesight conservation. Add to this the relatively high cost of luminaires at present and it is apparent that fluorescent lighting may not always be "low cost" lighting.

The fluorescent lamp need not be promoted only on the basis of low cost, for it has much to offer modern lighting in addition to high efficiency. It offers many new colors at efficiencies no other light source can duplicate; it provides a close approximation of daylight without the necessity of light absorbing screens; it generates "cool" light with only about one-quarter the radiant energy per foot-candle yielded by incandescent lamps; and it is so shaped that it may be readily concealed. These are advantages that any illuminating engineer clearly recognizes; but they are not of such universal importance that all other types of light sources may be discarded.

Many times these desirable characteristics must be purchased at a premium, especially when general illumination with fluorescent lighting is desired, as, for example, when comparing on an equal-foot-candle basis the cost of fluorescent lighting in an office with incandescent lighting at usual energy rates. However, the daylight color of the fluorescent lamp and the "cool" foot-candles it produces may readily justify the extra cost. It is quite probable that this cost differential may not continue to exist in the

Table III. Approximate Light Output of Fluorescent Lamps (Lumens)

Lamp	Daylight	White	Gold	Red	Blue	Pink	Green
15 Watt T-8	495	585	375	45	315	300	900
15 Watt T-12	495	585	375	45	315	300	900
20 Watt T-12	760	900	540	60	460	440	1,300
30 Watt T-8	1,230	1,440	930	120	780	750	2,250
40 Watt T-12	1,800	2,120					

Table IV. Wattage Loss in Various Types of Auxiliaries for Fluorescent Lamps (110–125 Volts)

Type of Auxiliary	Lamp Watts	Watts Loss
High-power-factor two-lamp ballast	60 (two 30-watt lamps)	$14\frac{1}{2}$
	80 (two 40-watt lamps)	$17\frac{1}{2}$
Ballasts for operation of single lamps	15	5
	20	5
	30	8
	40	13
Single-lamp control units (switch in end)	15	3
	20	$4\frac{1}{2}$
Single-lamp control units (thermal switch in case)	15	$4\frac{1}{2}$
	20	5
	30	9
	40	14

future, as soon as fixtures emerge from the experimental stage into standard designs. As in all lighting installations, regardless of the source of light, local conditions and the lighting objectives are the big factors to be considered in estimating comparative costs; general statements too often mislead.

APPLICATION TRENDS

The trend in applications of fluorescent lamps up to the present has favored their use for supplementary lighting where levels of 100 foot-candles or more were desirable or where its colors, coolness, and shape were great advantages. The greater majority of the two million or more

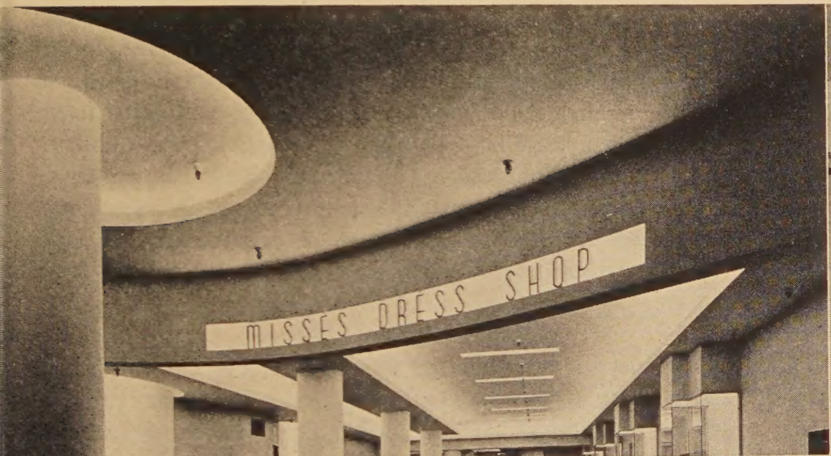

Figure 5 (upper left). Decorative fluorescent cove lighting combined with louvered troughs sunk flush with the ceiling provide 35 foot-candles in this large department store. White fluorescent lamps are used for general lighting and for special displays, wall cases, and the silhouette sign

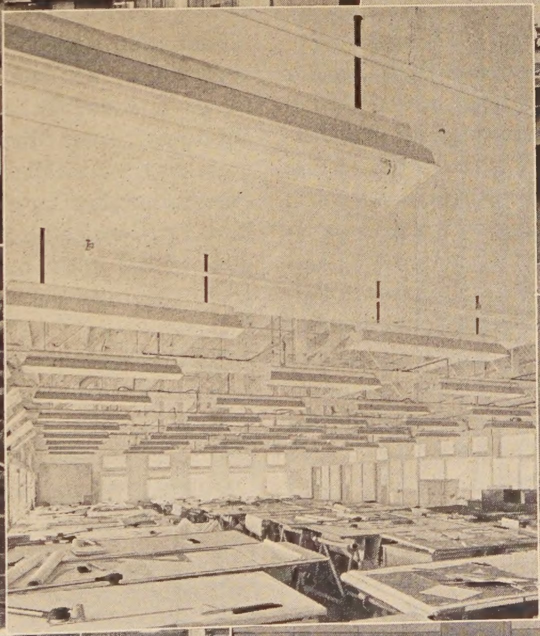

Figure 6 (center). New two-lamp RLM industrial fluorescent fixture on close spacing provides over 45 foot-candles of "daylight" in this drafting room. Two-lamp ballasts are a feature of these fixtures

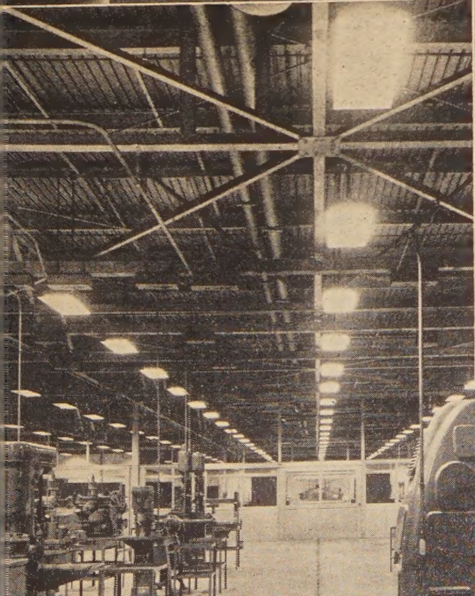

Figure 7 (lower left). Three 40-watt daylight fluorescent lamps in individual Alzak reflectors form the lighting units in this factory. The general illumination averages 25 foot-candles. Stroboscopic flicker is minimized by operating individual lamps on separate phases of a three-phase circuit

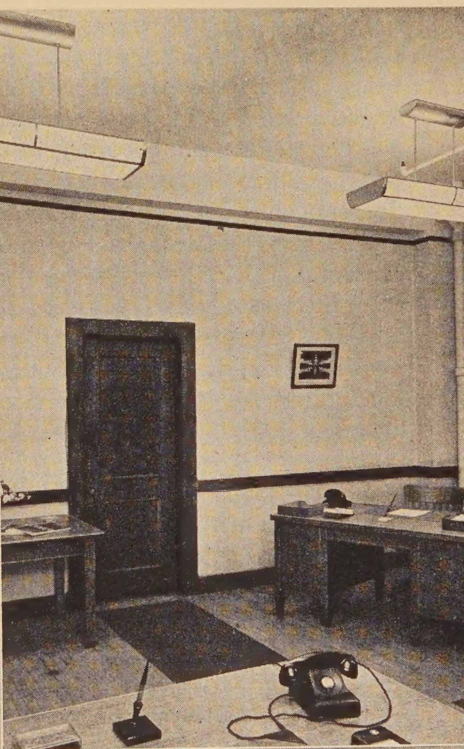

Figure 8 (upper right). Typical of latest fluorescent fixtures for general office lighting are the louvered fixtures in this office. Four 40-watt lamps in each fixture, operating on two-lamp high-power-factor controls, provide approximately 50 foot-candles on the desks

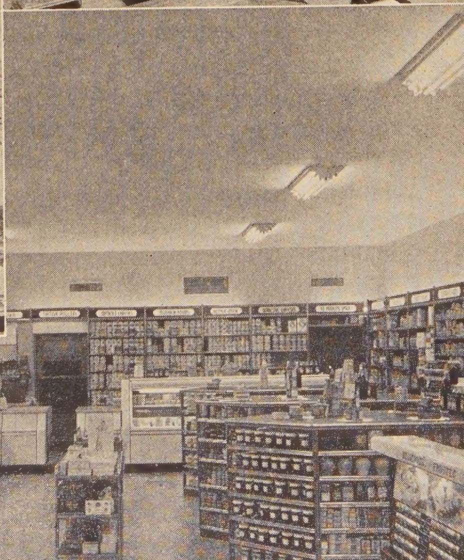

Figure 9 (lower right). Characteristic of the trend toward exposed-lamp fixtures is the fluorescent lighting in this grocery store, where high mounting and supplementary cove lighting from tops of shelves reduce glare. Showcase lighting also is fluorescent. In general, exposed fluorescent lamps are not recommended where eyesight conservation is a factor to be considered in the lighting design lamps sold have been installed for the following lighting purposes:

- Wall cases and showcases.
- Show windows (very small windows only).
- Decorative merchandise displays.
- Indoor directional signs.
- Supplementary cove lighting (figure 5).
- Art museums (supplementary).
- Industrial plants (for supplementary and for production line general illumination, figure 6).
- Night clubs, ball rooms, theaters.
- Bank cages and offices (supplementary lighting).
- Spotting and color discrimination (stores, printing, laundries, dry cleaning).

There is increasing interest, however, in general fluorescent lighting for industrial purposes (figure 7), in offices (figure 8), and in stores (figure 9). This new interest may be more or less attributed to the work of the RLM (Reflector and Lamp Manufacturers) Standards Institute and the Fleur-O-Lier manufacturers group in designing standard types of fixtures that meet the requirements of eyesight conservation as well as electrical requirements. The RLM Standards Institute has long been active in industrial reflector design, but the Fleur-O-Lier group is a result of the fluorescent lighting era. It consists of some 30 manufacturers of fluorescent equipment (fixtures and auxiliaries) who have joined together for the purpose of improving their product. Specifications have been prepared to govern general fixture designs, leading to electrical and eyesight-conservation excellence. A testing laboratory has been engaged to certify fixtures that meet these specifications. It is unwise to predict the extent to which these organizations will influence general acceptance of fluorescent lighting, but at least they will exercise a measure of control on luminaire design.

AUXILIARY HUM AND RADIO INTERFERENCE

Some such control of luminaire design is desirable, for the design and construction of the luminaire not only affects the lighting results, but determines to a great extent the noise or hum "level" of the installation. Noise or hum, of course, originates from the magnetic action in the choke coil elements and is aggravated when these vibrations are transferred to the supporting frame or metallic wiring channel of the fixture. The solution is not always easy, but if all controls are mounted on sponge rubber and attached to the fixture by bolts encased in rubber bushings so that metal will not contact metal, the possibility of excessive hum is greatly reduced if the metal used in the fixture is of good gauge and the fixture tightly assembled. Where absolute quiet is desired, the fluorescent lamp either should not be considered, or all auxiliaries should be located outside the room.

The possibility that the fluorescent lamp may interfere with radio reception also exists, especially if the receiving set is near the lamp. This interference may be attributed to three possible causes: (1) radiation from the lamp which usually may be corrected by moving the receiving set out of the field of the lamp (usually four times the lamp length) or by shielding the antenna in the radiation field and grounding the set; (2) line feedback of radio-frequency energy through the wiring circuit to the radio receiver, which can be stopped or minimized by the regular type of power filter; and (3) radiation from the wires carrying current to the lamp which can be partially eliminated by use of triple filters installed at the lamps. The problem of radio interference and its elimination has received much study, but fortunately little trouble has been experienced in practice.

COLOR CONSIDERATIONS

Other minor installation difficulties have given the engineer some concern. Since the lamp is essentially a low-pressure mercury-vapor discharge type, the spectrum of the mercury discharge is present in addition to the spectrum produced by the fluorescence of the inner coating. As a result, many popular interior colors for walls do not appear as attractive as under incandescent lighting. Some difficulty has been experienced in restaurants from the appearance of food under daylight and white fluorescent lighting. In general, the more vivid wall colors of "cooler" hue are desirable, and the best results in restaurants so far have been obtained with the new white lamp. The color of the light has also resulted in minor photometric difficulties, for the small vest-pocket "light meters", so commonly used today, are not calibrated to measure light of this quality. Two meter manufacturers have made available properly calibrated small light meters which measure illuminations produced by light sources of any color with an accuracy usually associated with such meters.

LOOKING AHEAD

After two years in service, the fluorescent lamp no longer can be considered a lighting novelty; it has proved to be a practical and adaptable light source, unusually efficient in the production of both colored and daylight illumination, without excessive radiant heat. It is generally agreed that the fluorescent lamp will not supplant all other light sources, but instead will supplement them, giving the illuminating engineer a further means of creating the high illuminations indoors which science indicates are needed for eyesight conservation. Its true value, however, cannot be measured entirely by what has been done with it in the past, but rather it should be judged by what the research engineer hopes to do with it in the future.

In the light of present-day research, its future looks promising, with much to be gained through further investigation of this principle of light generation. New colors, new sizes and shapes, and new efficiencies undoubtedly will come, but in the meantime the illuminating engineer has the important task of educating both himself and the public to utilize the high illuminations now possible indoors, perhaps for the first time, in a practical, comfortable, and economical way. Lighting tables will have to be revised, lighting design approached differently, and lighting equipment revolutionized. This important work is just getting under way.

Electricity in the United States Navy

LOUIS DRELLER

Electricity is used in the Navy as universally as on shore, and plants of 10,000-kw capacity are being installed on capital ships; much greater capacity, of course, is required where electricity is used for propulsion

ELECTRICITY is used on board ship for many purposes; for example, radio, interior communication, cooking, heating, lighting, steering, ventilation, and for training, elevating, and firing the guns. On some ships, as, for example, our electric-drive battleships and airplane carriers, electricity is used to drive the propellers. In short, electricity in the Navy is used as universally as on shore.

Electricity in the Navy may be said to date back to the first installation of an incandescent-lighting plant on the *Trenton* in 1883, about 57 years ago. The plant consisted of an Edison shunt-wound 110-volt generator having a capacity of about 13.2 kw. The generator was driven by a horizontal Armington and Sims single-cylinder steam engine with a steam pressure of about 30 pounds per square inch. This epochal lighting installation consisted of a total of 247 lamps rated approximately at 2,978 candlepower. Contrast this installation with our modern capital ships with electric plants of 10,000 kw, or the 200,000-shaft-horsepower electric-drive installation on the *USS Lexington* and you have some idea of the importance and growth of electricity in the Navy in half a century.

Probably the three outstanding electrical accomplishments in the Navy in recent years have been: (1) the introduction of electric propulsion on surface ships; (2) the use of alternating current in place of direct current; and (3) the development of Diesel d-c electric drive on submarines.

The electric plant on board ship, the same as ashore, consists of generators, distribution boards, power and lighting distribution panels, motors, controllers, transformers, motor generators, cable, and the various types of switchgear and protective equipment. The entire equipment must comprise a flexible, workable, reliable plant.

MAIN GENERATORS

The main generators are driven by either turbines or Diesel engines. The number and capacity of the generators depend in general on the connected load and specifically on the load demands imposed by the various conditions of operation, that is, at anchor, cruising, and during battle. For example, on a cruiser there will generally be four turbine-driven generators, two installed in each engine room. The number of generators varies from two on a destroyer or small ship to eight on a large capital ship. The capacity of the generators must be sufficient to meet the load demands during battle, even though some of the units are disabled or put out of commission by flooding, gunfire, etc. Thus, the primary object is to install generators in sufficient number and capacity to keep the guns and the necessary battle load operative during an engagement, even though the ship has suffered considerable damage.

In large plants, protection from short circuits as well as from gunfire and shock becomes important. Navy designers are therefore most interested in the detailed characteristics of design of generators as, for example, reactance, short-circuit ratio, and voltage regulation, and with their effects on the operation of the entire plant. This subject is receiving special study and consideration by both the Navy and generator builders. On ships in which direct current is used, the generators are generally of the 3-wire types, using 240 volts for power and 120 volts for lighting. On ships where alternating current is used, the generators are normally 450-volt 3-phase 60-cycle, wye-wound machines, normally rated at 0.8 power factor. The power-distribution system operates at 440 volts and the lighting system at 120 volts, obtained by means of air-cooled transformers.

Since the design of a combatant ship is always a compromise between speed, armor, and armament, economy in weight and space becomes of paramount importance in the design of all electrical apparatus installed on board ship. The Navy has been a pioneer in the development of lightweight high-speed generators, both turbine- and Diesel-engine-driven. Reduction in weight has been accomplished through ingenuity of design and the employment of lighter metals and alloys wherever practicable. In addition, all equipment installed on ships must be designed to withstand the corrosive effects of salt air as well as the vibration and shock incident to gunfire and to rolling and pitching. Hence, in addition to heat runs, overspeed, overload, and parallel tests required for commercial generators, Navy machines must pass certain inclination tests. The severity of these tests depends on the class of service for which the units are intended.

The electrical load on board ship varies considerably for the different conditions of operation. This variation in load is caused to some extent by the intermittent demands of the larger motors as, for example, steering-gear motors, training and elevation motors, and air compressors. To take care of these peaks and to insure that the generators are designed with sufficient factor of safety, Navy machines

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are required to furnish 125 per cent load for two hours and 150 per cent for five minutes without the temperature rise exceeding the allowable limits.

SWITCHBOARDS AND DISTRIBUTION SYSTEMS

Generator and distribution switchboards, which have developed rapidly in the last six or seven years, are in many ways the most interesting components of the electrical plant. The old live-front pressed-ebony-asbestos board with its knife switches has given way to the safe and attractive dead-front type of switchboard. Since the switchboard is the heart of the entire electric plant, it is receiving a great deal of study, particularly as to the type and mounting of circuit breakers and switches, current-carrying capacity of bus bars, arrangement of meters and instruments, and ease of maintenance. Here again weight and space are at a premium, and I venture to state without danger of contradiction that no commercial switchboards can compare in weight and space with Navy boards of equal capacity.

In addition to being designed for the necessary current-carrying capacity and creepage distance, each piece of equipment on the board, as well as the entire board, must be shockproof. It goes without saying that the equipment must be protected against corrosive action, and the bus bars and switchgear must be designed to withstand short circuits. The number of main switchboards varies from one on smaller ships to four on the larger ships. On a ship of the cruiser type there are normally two main and two emergency switchboards. The switchboards are composed of generator panels, bus-tie panels, and power and lighting distribution panels. The boards contain the necessary meters, control switches, indicator lights, and synchronizing equipment. The switchboards are connected together with bus ties, making it possible to use any generator or any combination of generators on the system.

The distribution system consists in general of feeders emanating from the main switchboards to lighting and power distribution panels located in various parts of the ship. The large and vital auxiliaries are usually fed directly from the switchboards. The other auxiliaries and the lighting circuits are fed from the power and lighting distribution panels installed in the various parts of the ship. Vital auxiliaries and systems are furnished with duplicate sources of supply. The distribution system is therefore a flexible and reliable installation, designed for its major purpose: to furnish power under the severest conditions to the vital auxiliaries and systems required during battle.

To obtain this degree of reliability, special care is necessary in the mounting and running of cables. The Navy specifications are very explicit with regard to spacing and mounting arrangements. The wireways must be sufficiently rigid and strong to withstand shock incident to gunfire, and the cable must be adequately spaced for ventilation and for ease of upkeep.

MOTORS

The motors used aboard ship conform generally to commercial machines, except for special protection against corrosion and the use of light-weight metals and alloys where practical in order to reduce weight and space. Most of the d-c motors used are of the shunt type. Compound-wound motors with the necessary torque characteristics are used for specific applications. In a-c installations, straight squirrel-cage motors with across-the-line starters are used wherever possible. Synchronous motors are used for propulsion and on the larger ships for motor generators; they are built for a leading power factor and are used for power-factor correction.

Motor controllers receive a great deal of attention. All component parts, as, for example, the contactors, relays, and switches, are given in addition to the normal tests, shockproof tests and must receive type approval before their use is approved.

CABLE AND ITS INSULATION

The subject of cable is of extreme importance on Naval ships and has received a great deal of attention in the last few years. To be satisfactory for shipboard use, the cable first must be a good conductor and be adequately insulated for the impressed voltage. Second, the cable must be designed so that it can safely withstand a high ultimate temperature. Third, it should be, in so far as possible, nonhygroscopic. Fourth, the cable must be sufficiently rugged and flexible to withstand the necessary bending, handling, and pulling during the construction period. Last, but not least, it should be flameproof, and at the same time withstand submergence in water. Since the available insulating materials possess their own physical and chemical properties and limitations, it is necessary to make certain compromises in the selection and treatment of the various materials in order to obtain a cable suitable for Naval use.

Until about 1922 the standard cable used in the Navy was the rubber-insulated lead-sheathed steel-armored cable, which provided excellent protection against moisture and was flame resistant to a high degree by virtue of the protection afforded by the lead sheath. However, since rubber and varnished cambric, which provided the insulating properties of the cable, are both inflammable, the cable would burn and support combustion if the lead sheath were punctured. Also, because of the low melting point of the lead sheath it is conceivable and probable that in battle, with severe short circuits caused by flying fragments and shells, the lead would melt and once a fire started in the cable, it would readily burn and the lead would drip. The resistance of the lead and armored cable to heat was low, 60 degrees centigrade being the universally accepted limit of safe operation. The cable could not be heavily loaded because of the small margin between the normal ambient temperature of 40 to 50 degrees centigrade and its ultimate safe operating temperature of 60 degrees. Also, the leaded and armored cable is heavy and has large diameter per circular mil of conductor cross section.

All in all, however, the leaded and armored cable was very satisfactory and, except where the cable was installed in very hot spaces, its length of life could be said to equal that of the ship. In fact some of this cable is still in use after more than 25 years of service.

The next step in cable development, about 1922, came with the substitution of varnished cambric for rubber for conductor insulation. The accepted limit of safe operating temperature for varnished-cambric cable became 75 degrees centigrade as against 60 degrees for the rubber, leaded, and armored cable. With the higher temperature rise, the ambient rating of the cable was materially increased. While the varnished-cambric reinforced-rubber cable is highly resistant to water, the cable is inflammable. Recognizing this fire hazard, the next step was the development of the so-called "flameproof cable" introduced about 1930. The use of this cable was restricted to engine rooms and fire rooms where the ambient temperature is high. Asbestos together with certain halogenated impregnated compounds provided the flameproofness. Not only was the cable flameproof, but it provided for an increase in the operating temperatures up to 90 degrees centigrade—about 15 degrees higher than the varnished-cambric cable previously used. Thus, aside from flameproofness, it permitted a further increase in loading capacity with a corresponding further reduction in weight. This type of flameproof cable had one material disadvantage: Because of the asbestos insulation, it was under certain conditions hygroscopic. Recognizing that this type of cable could be improved, the bureau of engineering of the Navy started an intensive campaign to obtain a more satisfactory fireproof cable that not only would withstand moisture but could be operated even when submerged in water.

In 1936 the present type of heat- and flame-resistant cable was adopted, which is considered to be at least the equal of the rubber and varnished-cambric cable in respect to resistance to water and salt air. As to its heat resistance and longevity, laboratory tests show that its present rating of 105 degrees centigrade is conservative. It is important to note that, due to its ability to carry greater amperes per circular mil and to the characteristics of the insulating material used, it has been possible to build this cable in very large sizes. This is an important advantage in reducing the number of cables, particularly in the large electric plants installed on capital ships. The major difference in the construction of the new heat- and flame-resistant cable, as compared with the former flameproof cable, consists in a synthetic sheath over the varnished cambric and asbestos. This synthetic sheath is impervious to water, moisture, and oil and is flame resistant to a high degree. The sheath may be applied either by taping or by extruding, and several different compounds are used by the various cable manufacturers.

The use of synthetic compounds for insulation is in its infancy and the surface has hardly been scratched. The Navy is cognizant of the possibilities of these compounds. They are used in a number of applications, and the Naval Service has been an important contributor in their development. The possibilities of glass insulation for both cables and windings also are recognized and for some years the Navy has been actively engaged in prosecuting the development of glass insulating tapes and has done considerable testing along this line.

A-C PLANTS ON SURFACE SHIPS

Commencing with the *Farragut* class of destroyers, about 1932 the decision was made to install a-c electric plants on surface ships instead of d-c plants which had been installed on all previous ships. This decision was based on the following reasons:

1. Increased reliability.
2. Decreased maintenance.
3. Reductions in weight and in spare parts.
4. Adoption of more nearly commercial equipment, particularly induction motors, starters, switchgear, and protective devices which could be easily obtained in wartime.
5. Improvement in design in future years expected to be more rapid due to the widespread use of alternating current in industry.

Experience in industry has shown a considerable decrease in maintenance, labor, and cost with a-c machinery as compared with d-c machinery. The use of a-c generators and motors eliminates commutators with all the attendant troubles inherent to commutation. Squirrel-cage motors are extremely reliable and, except in the large ships, there are relatively few on board that cannot be started with simple across-the-line switches, thus eliminating the complicated controllers necessary with d-c motors.

Transformers, perhaps the most rugged of all electrical equipment, are used to obtain various special voltages required on combatant ships. The transformers used are of the single-phase air-cooled type; they have given excellent service and are now being developed in sizes up to 100 kva. The scheme used is to connect the transformers in delta so that if one of the transformers is disabled, the lighting system can be operated in open delta.

Experience to date has demonstrated that the a-c plants require less maintenance and upkeep than the corresponding d-c plants. It is believed that this factor will become more apparent as the ships get older. A saving in weight over similar d-c plants has been realized, which for large capital ships can be conservatively stated as being about 20 per cent. Due to the reliability of squirrel-cage motors, it has been possible to eliminate the carrying of spare rotors. This item becomes important on a large ship on which there may be as many as 400 motors.

Another advantage is that a-c motors, transformers, and controllers are highly standardized. Also, the source of supply of a-c equipment is much greater than for d-c equipment. This factor becomes important in time of war where large quantities are required and the delivery time is short.

The success of the a-c plant depends to a large extent on the proper design of the alternators and associated voltage-regulating equipment. One of the reasons for this is that on board ship the horsepower of many of the motor-driven auxiliaries is large compared with the generator capacity. It should be remembered that in commercial practice the capacity of the central-station alternators is many times the horsepower of any single motor or power demand. Hence, the inrush currents as the result of starting of individual units do not materially affect or influence the basic design characteristics of the central-station alternators. In the design of the electric plant for shipboard use, the inrush currents due to starting large induction motors must be constantly borne in mind. The magnitude of the inrush current of each circuit is studied and the distribution system arranged so that practically all of the induction motors can be started satisfactorily across the line.

Shunt-wound d-c generators with voltage regulation of about 12 per cent were found best for service operation. In order to obtain an alternator economical in size and weight, the inherent regulation at rated load and power factor is generally poor, approximately 35 to 40 per cent. This regulation is unsuitable for shipboard use. Therefore, the success of the a-c generator depends primarily on the satisfactory operation of the associated voltage-regulation equipment. The regulators developed and installed have proved reliable and satisfactory, and their development is a tribute to the resource, co-operation, and ingenuity of the engineers designing this equipment for the Navy.

This is not the place to attempt to discuss the host of problems and difficulties that were met and ironed out in the development of the a-c plant. However, a few might be mentioned as, for example, speed control of motors, calculations of cable, development of light-weight high-speed, automatically operated Diesel generators that cut in on the line from cold start to supply emergency power after failure of main voltage, balancing of the phases, and short-circuit protection. In general, these problems have been solved, with the result that the changeover from direct to alternating current has been accomplished without trouble and with great benefit to the Service. The problem now is one of refinement, particularly along the lines of decreased weight and space, higher efficiency, and better shock proofness.

The technical bureaus and experimental laboratories of the Navy are reservoirs of engineering data and experience. Each design is based on the accumulated knowledge and design experience of the Navy personnel and of the great number of engineers and technicians in the commercial world engaged in building equipment and ships for the Navy. The ships themselves are the practical laboratories where the results of design and production are tested under service conditions. The "proof of the pudding" is in how the equipment operates on board ship.

The Navy is keenly aware of the future development of engineering in all phases and is continuously pushing new ideas and developments in order to increase the military effectiveness of the ships. It should be fully appreciated, however, that innovations in design and construction must be adequately proved before they can be installed on men-of-war. Equipment installed must be not only thoroughly reliable, but so designed that it can be kept in working order under the most trying conditions of warfare. The major objectives of reliability, ruggedness, ease of upkeep, resistance to shock and vibration, and economy cannot be compromised.

Power Preparedness

The electric-power industry of the United States is said to be capable of meeting any national emergency calling for more power capacity

WILLIAM McCLELLAN
FELLOW AIEE

PREPAREDNESS for war-time power supply or preparedness for war in any other respect, does not mean expectancy of war or desire for war. But just as one takes out a fire-insurance policy as a protection against what he knows may happen but hopes will not, so it is necessary to examine our resources and abilities as though we actually did have to face a war.

Electric power multiplies the effect of manpower and contributes essentially to lower production costs. Power is therefore fundamental to peace-time progress and even more so to war-time effort.

If power companies do not meet the power problems, the Government will do it for them. The Government has appointed a national power policy committee responsible for war power requirements and for peace power requirements as well.

What, then, is the ability of power companies to meet such emergency needs as may arise? First of all is the fact that growth is a tradition in the power industry of the United States. The power companies are accustomed to expansion as a normal and everyday policy. Not only are they accustomed to expand facilities steadily to meet growing demands, but they themselves have encouraged this growth through their sales efforts, one objective of this policy being to achieve greater economy and lower rates.

Moreover, it has been traditional with power companies in the United States to do more than merely meet growth as it occurs. It is their historic policy to keep ahead of demand, to have plenty of power on hand at all times for any need that may arise.

If war should come, it will find the managements of power companies good citizens, just as capable and willing

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Abstract of an address delivered at a meeting of the AIEE St. Louis Section, October 18, 1939.

WILLIAM McCLELLAN is president of the Union Electric Company of Missouri, St. Louis; he is past president of AIEE and of American Engineering Council.

to meet Government demands as they proved to be in the last war.

RESPONSIBILITY FOR POWER SUPPLY

That is power companies' responsibility: to provide an ample supply of power in any eventuality. And the time to think about it, the time to prepare—in plan, if not in actual construction—is now. What are the immediate duties of the power companies in this direction?

First, they should see that their present plants are reliable. Many plants are capable of carrying short peaks, but that does not mean they could run 24 hours a day, 365 days a year. When we speak of capacity we must recognize the difference between short-term capacity and ability to carry an equal capacity permanently. A plant capable of taking over a brief peak of 60,000 kw does not represent an actual 60,000 kw of full capacity.

The industry's next concern must be with reserves. When we are considering preparedness we must recognize that maximum reserve is necessary. Perhaps in many cases this means that construction schedules should be advanced. Even in normal operation we now need more reserves than we once did. The former practice of carrying one-unit reserve was made possible because summers, with their relatively low loads, gave opportunities for repairs. Now the load curve is flattening out; we have summer peaks as well as winter peaks, removing opportunities for repairs and bringing about a necessity for two-unit reserves.

EFFICIENT UTILIZATION OF INVESTMENT

The power industry must build ahead. Load growth is gradual, a little at a time; but additions to capacity must be made in large blocks at a time. That means idleness of investment for a time, a situation not, for the moment, altogether satisfactory to the stockholder; but further growth soon begins to absorb the added capacity and thus fulfill the obligations to the stockholders. Likewise, as the normal expected growth begins to utilize the added facilities, the industry avoids having in its rate base an idle investment that would be a burden on its customers.

TRANSMISSION—INTERCONNECTION

One factor that will contribute greatly to our power preparedness is the utilization of every possible opportunity for interconnection and exchange of power between systems. This constitutes, in effect, a sharing of reserves and an assignment of reserves to different localities at different times as needed. This, of course, is a familiar characteristic of the power industry and has contributed greatly to the efficiency of its operations and the economy of its service. In England interconnection has been enforced—through the so-called "grid system"—to the point where, under governmental regulation, permission must be obtained from the government in locating any new power plant. I can cite out of my personal experience the benefits of the exchange of power between Baltimore, Md., and Washington, D. C.,—millions of kilowatt-hours in each direction, profitably to both companies, each of which thereby becomes part of the reserves of the other, providing maximum reserve with minimum investment.

The balance between the necessary provision of reserves and the efficient use of dollar investment—the necessity of earning on stockholders' investment in facilities—must be considered along with all other factors, including the consumers' interests. Suppose, for instance, the Government should decide to build a factory at a given point. Should the necessary resulting power reserve be incorporated in the rate base of the residents of that area? In normal times it is not the power companies' right to burden the consumers of a given locality with a disproportionate rate base, or stockholders with an idle investment, by providing reserves far above the needs of adequate service. But in a war, individual rights and corporate rights become subject to demands of the Government.

MANUFACTURING LIMITATIONS NECESSITATE PLANNING

The necessity for present preparedness grows in part out of the limitation of turbine-manufacturing facilities. There are only three major manufacturers of large turbines in the country and they are engaged in building equipment for naval, military, and industrial purposes, as well as for central stations. This emphasizes the necessity of far-sighted action on the part of the power industry.

On the other hand, there are certain measures that can be taken in the utilization of power that will help in an emergency situation along with efforts to provide additional power. For example, factories now working on 8-hour shifts can change to 16- or even to 24-hour shifts, thus trebling their production with no increase in the kilowatt demand.

When it is a case of building new factories to supply needed materials for war-time use, if the power companies do not already have the necessary reserve of power to serve it, they can certainly supply this as quickly as any factory can be built and put in operation.

There is an even further line of defense if power demands are still greater. That is the rationing of power—for instance, cutting our residence load 10 or 20 per cent and turning this power supply over to industry.

POWER INDUSTRY HAS ABILITY TO MEET NEEDS

We recognize one fundamental fact. In a national emergency calling for more power capacity, if the power companies do not supply the power, the Government will. But we know, too, and so does the nation generally, that power companies are capable of meeting any such emergency. They have the engineering abilities and the financial resources (we may assume that any crippling regulatory restrictions or penalties would be removed) and they have behind them a habit and a tradition of growth which would enable them to take such an assignment completely in their stride.

Our own good citizenship will lead us in the power industry to do our part, not only in such an emergency as may arise, but in anticipating our duty immediately. As good citizens, we will build up to the maximum peace-time reserve; we will be sure that our systems are so interconnected as to give maximum service and maximum reserve.

The Ionosphere

KARL K. DARROW

A physicist "looks at the ionosphere", that electrically conducting envelope surrounding the earth hundreds of miles above its surface which is so essential to radio, and reviews current facts and theories concerning it

SOME YEARS AGO there was a flood of books bearing such titles as "The Doctor Looks at Love", "The Lawyer Looks at the Law", "The Poet Looks at Civilization", etc., etc. I might have followed their precedent by naming this lecture "The Physicist Looks at the Ionosphere". Better would have been to say "The Physicist Listens to the Ionosphere"; for while the actual procedure is neither listening nor looking in the usual senses, it is rather more like listening. As a matter of fact we have all of us listened to the ionosphere—all of us excepting those who as yet have never hearkened to a broadcast from long distance, and who must by now be few. Any program which is heard from more than a few hundred miles, and does not come by wire, comes by courtesy of the ionosphere. When we are lending ear to such a program, we are listening both to the loud-speaker and to the ionosphere, since both take part in the transmission. Of course we are likely to be listening also to the news; but nowadays the news is generally dismal or frightful or both; and it should be happiness to be diverted for a while from what the ionosphere brings to the qualities of this innocent agent itself, which is not in the least to blame for the evil which it reflects.

I suppose it would be logical to begin by expounding the mathematical theory, to describe next the techniques of experiment, and so come finally to the results. This would, however, be a long hard path, and we should be in danger of wasting much effort in exploring mathematical byways traced in the expectation of results which have not as yet been attained. The order will therefore be as follows: first a statement of some of the main results, then a glance at the experimental methods, then a brief but not particularly easy excursion into the theory, and finally a return to the results with as much additional detail as the space will allow. Now I will call at once upon the illustrations to supplement my words.

Figure 1 shows a segment of the surface of the earth, and on it an aerial which is engaged in emitting wireless waves. The vertical lines rising from the surface are meant to indicate the wave fronts of the energy which is radiated horizontally or nearly so. They are so drawn as to show this "ground wave", as it is called, dying out within a few hundred miles of the starting point. If we could hear only by means of the ground wave, this would mark the limit of transmission. But above, run lines to indicate the paths of the energy radiated in various upward directions; and there is something which reflects them, so that they return to the earth. It is this something, this reflector for radio waves, this electrical mirror over the earth, which concerns us.

This mirror is what for the last few years has borne the name of "ionosphere". The former name was Kennelly-Heaviside layer; for Kennelly and Heaviside—there is no need of recalling who they were—having been impressed by the fact that the ground wave dies so early, came independently to the conclusion that in the upper air there must be a conducting layer to send back the upward-headed waves. That was in 1902, a time at which the notion of conductive air was almost revolutionary. Ordinary air, as we all know, is a very good insulator; Kennelly and Heaviside were supposing that at high altitudes this quality would be reversed, which was a rather daring speculation. Five years earlier than 1902, it might have been too daring for anyone to risk; but by 1902, people were beginning to know and to understand that ultraviolet light has the power of converting nonconductive air into a conductor, by detaching electrons from the molecules thereof. Well, there is certainly plenty of ultraviolet light falling out of the sun into the high atmosphere, though very little of it ever gets down to the depths where we live; so here, at one stroke, I have stated our present idea of the ionosphere, and also our idea of the principal agent which makes it what it is. Sunlight, perhaps with the aid of other agents as well, converts the upper atmosphere from an ordinary gas of neutral molecules into a mixture of two electrified gases with one which is neutral. One of the electrified gases consists of free electrons; the other consists of the positive ions which are the molecules from which the electrons were torn; while the neutral gas consists of the molecules which as yet are unaffected. This is the simplified picture which I wish now to substantiate in the main, but of which I must also point out in due time some of the flaws.

Perhaps there are some among you who will think it strange that a mere gas—especially a very rarefied gas, and particularly a gas composed of particles as light as electrons—should serve as a mirror. Would it make you any happier, if I were to say that up in the sky there is a smooth hard ceiling like that imagined by the Greeks, made, for example, of nicely polished and perfectly reflecting

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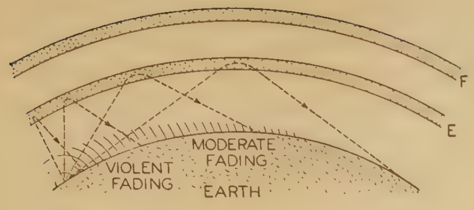

Figure 1. Trajectories of radio waves, with oversimplified model of ionosphere (after Mimno)

silver? Well, I shall say nothing of the sort; but instead I will say that when visible light is reflected from a hard solid mirror of silver, it is not the hardness of the silver which is doing the reflecting, but just another electron gas which is diffused through the pores of the metal! A metal mirror is a container for an electron gas, but here in the upper air we have an electron gas without a container, and both of them are able to reflect. Later on I will show you some of the equations for their reflecting power, but we are not yet finished with figure 1. I want now to use this figure to show how the elevation, the altitude of the electronic mirror over the earth can be determined.

One way of measuring this altitude is very obvious—if, that is to say, it will work. Suppose that the observer is able to go a measured distance away from the aerial and measure there the angle which the reflected wave or "sky wave" (as it is called, to distinguish it from the ground wave) makes with the vertical as it comes down to him. If this can be done, then evidently he can get the altitude by the simplest trigonometry. It *can* be done, and it was done by Appleton and Barnett in 1925.

Another scheme is much more complicated, and I can give only the merest glimpse of it. It is a clever way of putting to useful service the very great inconvenience which the radio people call "fading". They have a curious usage for this word: to me as a physicist or as a writer, "fading" suggests a signal which dies out and never returns, but to a radio engineer it seems to mean a signal which dies out and then comes back again and keeps on doing this over and over again, in a most irregular fashion. This sort of thing happens in the regions where the ground wave and the sky wave both arrive and overlap one another, and it is due to what in optics is called the "interference" of the two waves. If conditions were absolutely stable, then in taking a little walk one would pass through several maxima and several minima of intensity. Since conditions are never absolutely stable, the observer need not take the walk; even while he stays at a fixed point, the maxima and the minima just float past him as the electronic mirror wiggles up and down in the sky. Now suppose him standing still, at a moment when the conditions are relatively stable; and suppose that the engineer at the sending aerial changes the wave length by a small and known amount; several maxima and minima will float right past the observer, and by counting them he can (though this is not at all obvious!) get a datum which will enable him to figure out the altitude of the reflecting layer in the sky. This method also was invented by Appleton, and can be found explained in the literature under the name of "wave-length-change method".

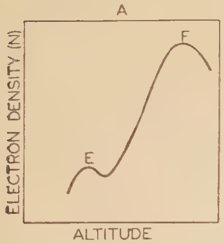

Figure 2A. "Curve of inference": conjectural dependence of number N of electrons per unit volume on true altitude h

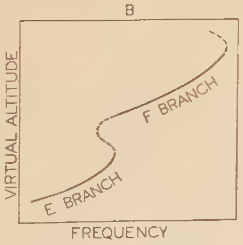

Figure 2B. The "curve of data": dependence of virtual altitude h' of ceiling (one-half the delay of the echo, multiplied by c) on frequency f

The third method is the only one which henceforth will figure in these pages. It is the "method of echoes" (sometimes called by the clumsy name of "group-retardation method"). This was invented and first applied at the Carnegie Institution of Washington by Breit and Tuve.

To introduce it I recall that in figure 1, the two bands represented layers populated with electron gas; and now I call attention to figure 2*A*, which is a graph of the density or concentration of that electron gas—N electrons per cubic centimeter—plotted against elevation over the ground. (By the way, whenever I speak of the distance of anything above the ground, I intend to use the words "elevation" or "altitude", so as to reserve the word "height" for the heights of peaks on curves; thus the words "height" and "high" shall always be taken in reference to curves, and never in reference to distance up in the sky.)

It is evident that if figure 2*A* corresponded exactly to figure 1, the curve would consist of a pair of square-topped rectangles. But as almost every reader must have guessed, figure 1 was oversimplified, and whatever the truth may be, figure 2*A* with its smoothly bending curve must be closer to it than figure 1. Figure 2*A* looks like the cross section of two mountain ranges; and there are places and times of day when there would be four distinguishable mountain peaks instead of only two.

Now I am going to hold to this naïve metaphor of mountains for a little while; and first I will ask you to imagine that you are looking, from a great distance on the left, onto actual mountains like these. In such a case you would never see the valleys between the mountains, and of each peak beyond the first you would see only just so much as might rise above the peak next preceding it. The first point to be made is that the echo method suffers from the same limitation, and that is why the parts of this curve which slope downward to the right are shown in dashes; the data say nothing about them.

Of course if you were actually looking at earthly mountains, you would be seeing them by light which comes from the sun and is reflected by them to your eyes. Once in looking up the early history of optics, I came upon the idea of some Greeks who believed that light is something which springs from the eyes of the looker, races over to the object to be looked upon, and then comes back to the looker's eyes bringing its report. The idea is ascribed to the Pythagorean school, and also to others who may or may not have had it from Pythagoras. Well, I wish that Pythagoras could be with us now, for he would certainly be pleased to discover that all unwittingly he had foreseen the present-day method of looking over the ionosphere. We use invisible light instead of visible, and the waves spring from our apparatus and come back to our apparatus instead of springing from and coming back to our eyes; but the principle is the same, and that is what is signified by the name of "echo method".

Now let us recall for a moment how acoustic echoes would behave, if instead of looking from the left at this mountain range, one were shouting at it with an enormous voice. After a while one would get an echo from the front side of the smaller peak, and after a longer while, a second echo from the overtopping part of the larger peak. One could measure the lapses of time between the departure of the shout and the arrivals of the two echoes, multiply it by the speed of sound in air, and the products would be the doubled distances from the shouter to, roughly, the midway points of the slopes. Some of the early work on the ionosphere by the echo method was not very different from this, and presently I will show you the traces of such pairs of echoes. However, the method is very much more subtle, because of a feature not exhibited by acoustic waves. I am now going to lead you for a couple of minutes into an imaginary world where sound waves *do* have this feature, to show you how strange it is.

Imagine then that the laws of sound are so strangely devised, that every pitch is reflected from one particular height on the mountainside, and the shriller the pitch, the greater the height of reflection. A basso profundo, we will imagine, will then be echoed from the bottom of the first peak; a baritone from its middle; a tenor from near its top; the voice of a contralto might slip over the summit of the lower peak and be reflected from the taller, the voice of a sufficiently high soprano might go over both and never be echoed at all. Imagine further that in this remarkable world you have the entire cast of an opera at your disposal, and order them to sing their scales from the very bottom bass to the very topmost soprano—and listen for the echoes. As the voices clamber up the scale, the echo will be more and more delayed, but at first the change will be gradual. Suddenly however will come a pitch—I suggested that it would occur somewhere between tenor and contralto—where the delay of the echo will suddenly and sharply rise; and this will be the pitch corresponding to the height of the first peak. Later on there will come a pitch—somewhere in the high soprano—at which you may listen forever, and yet the echo will not come back. This corresponds to the height of the taller peak. If you knew the relation between frequency and height of reflection, you then could figure out the heights of both the peaks. Indeed you could even make a tracing of their slopes, except in the valley between; but now it is time to lay aside this simile, and go back more closely to the data.

The curve of figure 2*A* (to repeat) is a crude conjecture of the trend of the density N of electrons in the ionosphere plotted against the altitude h over the ground. Now think of a beam of wireless waves of some definite frequency f mounting up through the air—mounting *vertically*, let us suppose, since it is thus that most of the experiments are done. The beam will penetrate the ionosphere until it reaches an altitude where the electron density has a certain particular value depending on f. Here it will be echoed—reflected—turned back and sent back to the earth. The electrical mirror of my first analogy is located, for this particular frequency but only for this one, at the altitude where this particular electron density is found; and therefore I will call the latter "the mirror density," $N_m(f)$, for the frequency f. Where the density attains the value $N_m(f)$, there the waves of frequency f find their mirror. Densities less than the mirror density will let the waves go through. Greater densities would stop them indeed, but do not get the chance, being ordinarily underlain by strata where the density has the mirror value precisely.

In going up to the mirror level in the ionosphere and coming back therefrom, the signals take an appreciable time. Please note the replacement of "waves" by "signals" in that phrase! It is of the first importance. If one were to send a steady long-continuing wave train into the sky it would be of no use, for one would not be able to distinguish its echo from itself. The wave train must be interrupted so that there is nothing left of it but one or a series of pieces—the "signals", "pulses", or "groups"—each of which goes forth as an entity limited in time and is echoed back as such an entity. The speed of such a signal or group is not the same as the speed of the waves, a paradox which is one of the stumbling blocks of physics. It is the group speed v which determines the time of going and returning, the "delay of the echo" as I will call it.

I do not wish to imply that this "delay of the echo" would be appreciable on an ordinary clock! It is of the order of milliseconds, as one sees in figure 3 which will make the echoes vivid in the reader's mind. Here we see sharp sudden deflections or kicks made by an oscillograph in the receiving device. The kicks marked G are the signals just departing from the sender; the rest are echoes. Those marked with subscripts 1 . . . 5 have been reflected one to five times from the ionosphere, all but the first having been re-echoed from the ground.

In studying the ionosphere, one measures the delay of the echo for as wide a range of frequencies as one's apparatus will allow, and so the data come out in the form of a graph with frequency of waves and delay of the echo plotted one against the other. The curve of figure 2*A* is a curve of inference; but now, proceeding in just the opposite direction from the investigators, I am going to take

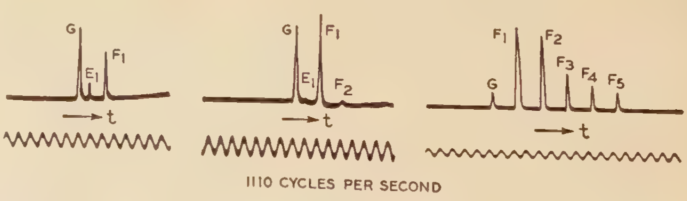

Figure 3. Echoes: G, original signal; E_1, F_1 echoes returning after a single reflection from E and F respectively; F_2 . . . . F_5, echoes which have suffered two to five reflections at F layer (Appleton and Builder)

you backward from this "curve of inference" to the forthcoming curves of the data.

Evidently, if mirror density were exactly proportional to frequency, and if delay of the echo were exactly proportional to altitude of the echoing layer, we should have just the same curve over again with different symbols and scales along the axes. But the relations are not nearly so simple, and so the curve of data is distorted from the curve of inference.

In the first place, mirror density is proportional not to the frequency but to the square thereof, as I will soon be proving. The distortion due to this is easy to allow for.

But in the second place, the delay of the echo cannot be proportional to the altitude of the echoing layer unless the speed of the signal is constant; and this is not so. While the signal is voyaging through those regions of the ionosphere where the electron density is already high though not so high as the mirror value, its speed is reduced, and often reduced considerably. This *is* a tough distortion to allow for, since it depends not on things already known but upon the very thing one is striving to find out, to wit, the distribution of electron density in the ionosphere! The problem is somewhat like having to solve for x an equation in which x appears badly entangled in both members of the equation. There will shortly be an occasion for saying a little more about this distortion; for the moment I will mention only that in spite of it the curve of the data retains the major features of the curve of inference.

To sketch the curve of data, then, one would begin by making a rough copy of the curve of inference with its shorter and its taller peak. But to come into harmony with usage, one must turn the axes through 90 degrees, so that delay of echo shall be plotted vertically and frequency along the horizontal axis. Now the peaks are lying on their sides; and now it is easy to see, in virtue of what I was lately saying, that in the curve of data they appear just as two separated branches with a gap between. For imagine the observer making his tests by going step by step from low frequencies toward high; the points depicting his observations will lie first along the slope of the shorter hill, then jump to the taller hill and follow along *its* slope till its own peak is reached, and then there will be no more, for the echoes will have ceased. Figure 2*B* is drawn with the observable branches of the curves heavily scored, the unobservable parts reduced to chains of dashes.

We shall see very soon that the curves of data are recognizably like that of figure 2*B*; but beforehand I ought to acquaint you with some technical terms and some further details.

Now that the peaks are lying on their sides we call them "layers", coming thus into conformity with usage and with the facts, for of course they stand for horizontal strata of ionized air. Thus far we have distinguished two of them; the one nearer the ground is called the E layer, the one further up in the sky is lettered F. (The names Kennelly-Heaviside and Appleton for E and F are sometimes seen.) The branches of the curve of data which lie to left and right of the gap may be considered as the profiles of the undersides of these layers, subject to the distortion to which I have already alluded. I will call them E branch and F branch, though this is not a general usage. At the right-hand end of the E branch is the highest frequency which finds a mirror density in the E layer, and at the left-hand end of the F branch is the lowest frequency which can penetrate the E layer and so reach on to F. The latter must be infinitesimally higher than the former, but in practice one does not draw this fine distinction, and the names "penetration frequency of the E layer" and "critical frequency of the E layer" and the symbol f_E are applied to them both indiscriminately. Similarly, the right-hand end of the F branch shows to us the penetration frequency of the F layer. There are times of day and year when the curve of the data may be composed of three or even of four branches, indicating as many distinguishable layers; these are then denoted by E_1 and E_2, F_1 and F_2 in order of increasing altitude. It is clear that the notation is in danger of becoming cumbrous, should any more layers ever be identified among those already lettered.

One more detail: The customary ordinate, in such graphs as we are about to study, is not T the delay of the echo but one-half of cT the product thereof by c the speed of light in vacuo. This is the altitude which one would assign to the mirror level, if one could believe that the signal travels to and fro with the speed c. It is denoted by h', and is called "equivalent height" or "virtual height": I will call it "virtual altitude" so as to preserve the distinction between altitude and height which I am trying to keep in this lecture. It is always greater than the actual altitude, since the signal always travels with a speed lower than c; the difference is the complicated distortion which I mentioned above. Now that we have encountered again this distortion, I will state one of its important features. The distortion, or in other words *the excess of virtual over actual altitude, is greatest for frequencies close to the critical frequency of a layer:* for signals of these frequencies must travel through regions where the electron density is close to the mirror value, and this is the condition for the maximum of slowing-down. It is easy to see that owing to this feature of the distortion, the natural uptrend of the right-hand end of every branch (due to the fact that actual altitude of mirror level increases with frequency) will be exaggerated. Moreover (and this is worse) the left-hand end of a branch is likely to show a downtrend which in a curve of actual altitude against frequency would not be there at all. And now at last we turn to actual examples of (h', f) curves, as these curves of the data are called by Appleton.

Figure 4 is taken from the immensely extensive work of Appleton and his school. As happens so often in expositions, the reader has not yet been prepared for all the detail which it shows; I must ask him to ignore for the present the curve marked with crosses, and fix his attention on that with the circles. Here he will see the E branch, the gap, and the F branch deformed by an enormous hump or crinkle before it finally sweeps upward toward its critical frequency. It is supposed that the crinkle would be another gap, but for the distortion which has

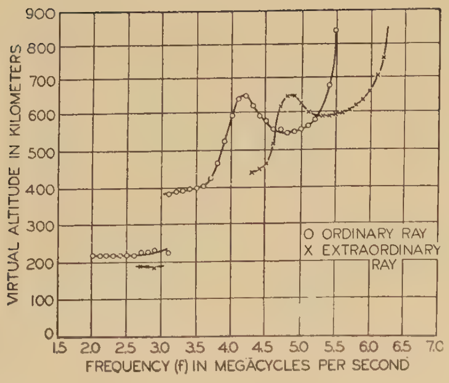

Figure 4. Example of characteristic or (h', f) curves, showing gap between E branch and F branch, and crinkle in F branch indicating presence of F_1 layer. Duplication of curve due to earth's magnetic field (Appleton)

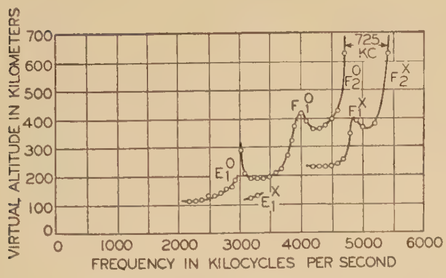

Figure 5. Another example of (h', f) curve, showing gap and crinkle (Schafer and Goodall)

twisted the curve upward from both sides toward the maximum. It is therefore taken as evidence for an additional peak, or perhaps a ledge or terrace on the side of the main F peak; to this peak or terrace or ledge the symbol F_1 is applied.

Figure 5 is a similar curve from Bell Telephone Laboratories, showing the gap, the crinkle, and the curvatures which on the left of every branch are wholly and on the right are partly due to the distortion.

So great is the interest in curves like these, and so much do they vary from time to time and from place to place, that lately (according to Appleton's count) there have been more than a score of stations over the world engaged in making them. At some of these productiveness has been enhanced and toil reduced by a machine developed at the Bureau of Standards and the Carnegie Institution. Automatically sending out the signals ten times in a second, and changing the frequency by (on an average) 1,600 cycles between each signal and the next while the photographic film is moved by a tiny distance from right to left, this "multifrequency apparatus" traces the curve of h' against f over the frequency range between 0.516 and 16 megacyles in 15 minutes and then goes back and does it all over again and again.

Figures 6, 7, and 8 show curves thus automatically taken, selected for bringing out one feature or another. In figure 6 are curves with crinkles in the F branch, recalling Appleton's of figure 4. In figure 7, however, the crinkle is missing, and the F branch sweeps smoothly and slowly upward from its commencement, forking before the end. Many observations have concurred in showing that the crinkle is present only when the sun is high in the sky, therefore absent by night and at the beginning and end of day, and indeed absent *all* day in winter where the latitude is high. This is our first example of the dependence of the ionosphere on sunlight, a very important feature! In all of these figures the curves are repeated several times along the vertical direction. This indicates echoes which have traveled four, six, eight or more times between earth and ionosphere, being reflected at both ends of the path; the earth below is a mirror like the free electrons above. Figure 8 shows a wonderful multitude of such echoes.

The curves of figure 9 are sketches based upon many. Contrasting those on the left with those on the right, we see the crinkle prominent in the ones, missing or faint in the others. This is the difference between summer and winter. All of the curves were taken near noon, but though the District of Columbia is not precisely in polar latitudes, the sun in December does not rise far enough in Washington's sky to bring out that feature of the ionosphere of which the crinkle is the sign. Running the eye up either column, one sees the curve lengthening out to the right as year follows year. During this sequence of years the sunspots were steadily growing more frequent: The sun was in the ascending part of that 11-year cycle of its fever, of which the sunspots are one of the manifestations, while the form of these curves is another.

Having seen so many curves which are either doubled or forked, the reader has a right to know the cause of forking and doubling in advance of due time. It is the magnetic field of the earth. Were I to attempt to give the theory thereof along with all the rest, this lecture would be transformed into a treatise. I dare not venture on more than the basic theory, with subsequent brief mention of what is done to it by the magnetic field and another complicating factor. Leaving these for the present aside, I now exhibit the basic theory by deriving *the formula for computing the mirror density from the reflected frequency.*

To situate this formula correctly in the frame of theoretical physics, I must go back to Maxwell.

The famous equations of Maxwell, when treated in a way which we all have been taught (or should have been) melt together into a wave equation. The waves which it describes consist of an oscillating electric field which I will

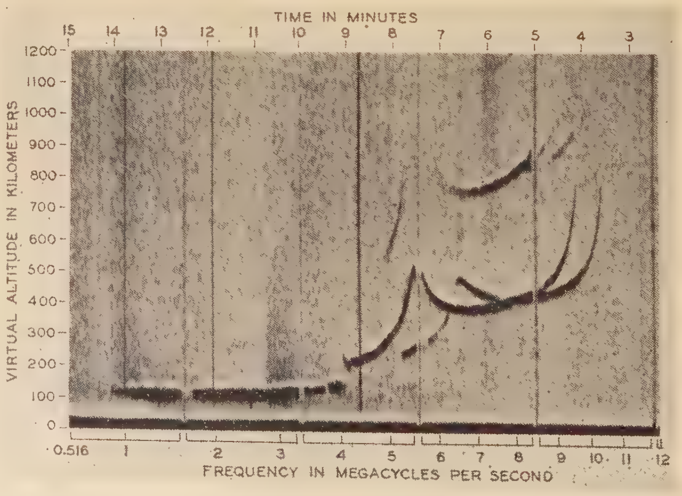

Figure 6. Characteristic (h', f) curves obtained with multifrequency sweep apparatus; sun high in sky, F_1 crinkle apparent (Carnegie Institution of Washington)

call $E_0 \sin nt$, and also of an oscillating magnetic field which for the present purpose we are allowed to ignore. When of high frequency, these are the waves of light, as Maxwell knew; when of low frequency they are the waves of radio, which Maxwell never knew because of his premature death some years before they were produced. In the wave equation describing these waves, there occurs of course the wave speed; I will call it u. Here then is the great idea of Maxwell: *The square of the wave speed varies inversely as the current density provoked by unit amplitude*[1] *of the oscillating field.*

Now we see at once that in the ionosphere the wave speed must be affected by the presence of the free electrons, since they are set into oscillation by the waves and therefore contribute to the current density!

At this point, those of us who were educated in the electronic era—and that is a class which probably includes most of the audience—are in some danger of falling into a serious error. We may in fact assume that the electrons constitute the whole of the current, and therefore deduce that in vacuo the oscillating field provokes no current at all, and hence that the wave speed in vacuo is infinite—which is absurd! Maxwell was wiser. He understood, and he put it down in his theory, that wherever there is an electric field which is changing with time, the rate of change of that field is equivalent to a current density. This he called the "displacement current" and for the case of vacuum he said that the displacement-current density is precisely equal to the rate of change of the field, multiplied by one of those tiresome factors $1/4\pi$ that are always popping up in the electromagnetic theory (although in some unit-systems they are few). In the vacuum therefore there is a current density $(1/4\pi)$ times the rate of change of $E_0 \sin nt$, and it therefore has an amplitude of $(1/4\pi)nE_0$ and is 90 degrees ahead of the field in phase. To this current density corresponds the speed of light in vacuo, the well-known constant c.

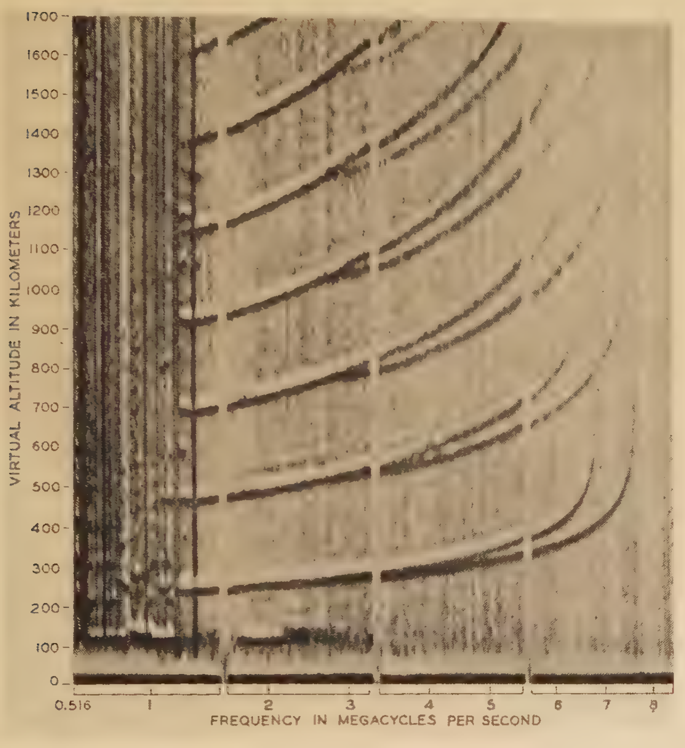

Figure 7. Characteristic (h', f) curves obtained with the multifrequency apparatus: sun low in sky, F₁ crinkle missing (Carnegie Institution of Washington)

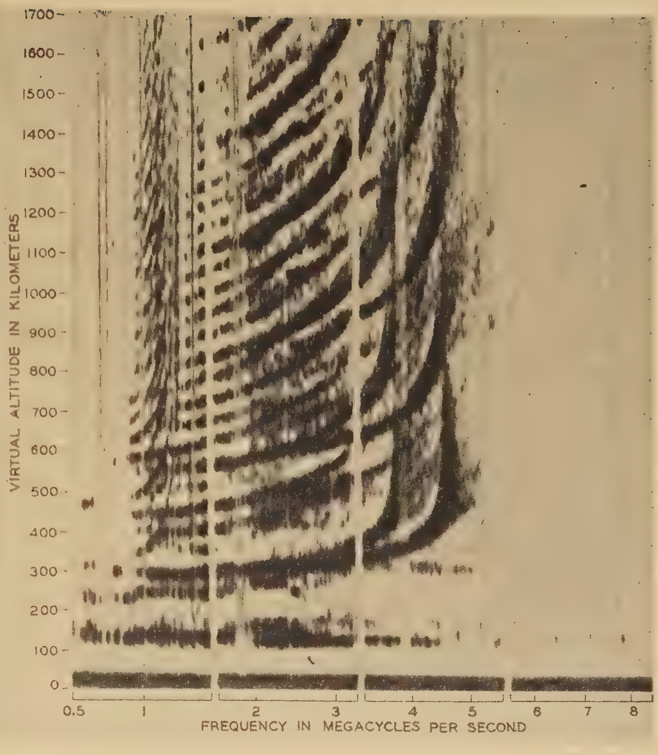

Figure 8. Multiple echoes (Carnegie Institution of Washington)

When the waves pass out of vacuum or out of ordinary air into the ionosphere, we still have the displacement current but now in addition we have, superposed upon it, the current of the electrons. Here is a second pitfall. It may seem obvious that the electron current must add on to the displacement current, creating a total current density greater than that in vacuo and therefore lowering the wave speed. Not so at all! The point is, that when the electrons are truly free, the field sets them into oscillation in such a curious way[2] that when they become adjusted, they are oscillating with their velocities 90 degrees behind the field in phase. Their contribution to the current, being proportional to their velocity, is also 90 degrees behind the field, and hence in perfect opposition of phase to the displacement current. Therefore the electron-current density—call it I_e—is to be *subtracted* from the displacement-current density! Accordingly I write

$$\frac{u^2}{c^2}=\frac{n(1/4\pi)E_0}{n(1/4\pi)E_0-I_e} \tag{1}$$

The reader may suppose that the factor $\sin nt$, common to

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[1] I introduce the words "unit amplitude" to save the reader from drawing the erroneous inference that wave speed depends upon wave amplitude.

[2] Well known, however, to anyone who has studied the theory of simple harmonic motion.

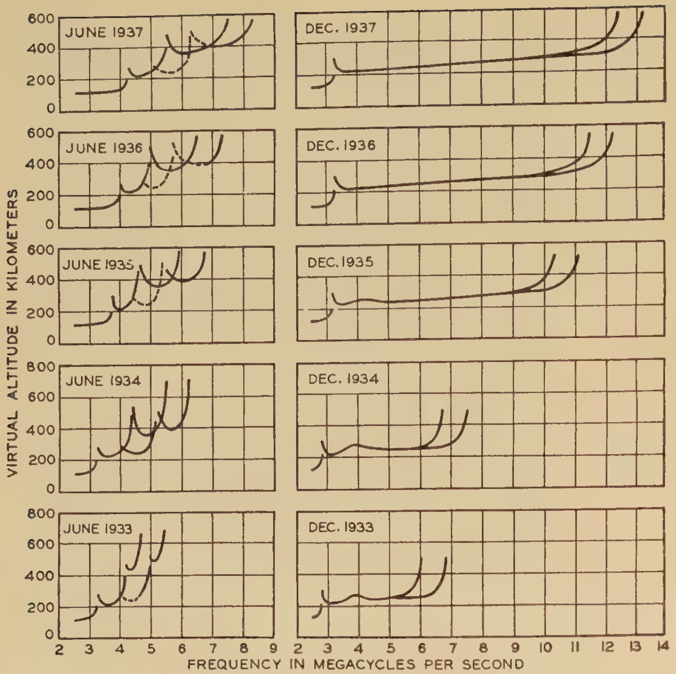

Figure 9. Dependence of (*h′*, *f*) curve on season and on the sunspot cycle (Smith, Gilliland, and Kirby: National Bureau of Standards)

both currents, has been divided out.[3] The quantity I is clearly proportional to E_0 and also to our familiar N the density of electrons, and in fact the reader can undoubtedly work out with ease that it is equal to NE_0e^2/mn (Here e and m stand for the charge and mass of the electron, as is customary). Therefore we find:

$$\frac{u^2}{c^2}=\frac{1}{1-4\pi Ne^2/mn^2}=\frac{1}{1-Ne^2/\pi mf^2} \tag{2}$$

The wave speed is greater in the ionosphere than it is in vacuo or in ordinary air. (The speed in ordinary non-ionized air is so nearly equal to c that we shall always ignore the difference.)

I pause to give the reader one more warning against confusing the speeds of wave and signal. The signals do not travel with this speed which is greater than c (if they did, the theory of relativity would be sunk!) but always at a rate[4] inferior or at the most equal to c. Now take note that equation 2 affirms that if ever N should be equal to $\pi mf^2/e^2$ the denominator on the right would vanish, obliging wave speed to be infinite! Of course it is not uncommon in theory for an equation to propose for some physical quantity under certain conditions an infinite value, which in practice has no meaning because the conditions can never be realized in nature. This is no such case. When frequencies usual in radio are inserted for f, the values of $\pi mf^2/e^2$ are perfectly plausible ones for N to have; and therefore we must reckon with the vanishing of that denominator. To show what that vanishing must mean, I will recall the refraction of light between, say, air and water.

In figure 10 the water is shown as lying underneath the air, not only because that is how it generally lies in nature, but also because the sketch will now fit both sides of the analogy. Passing from air into water, a beam of light is refracted—as everyone knows—toward the normal or vertical. This is because the wave speed of light is smaller in water than in air. Passing from water into air, as the arrow suggests, the beam AOA' is refracted away from the normal, for now it is going into a medium where the wave speed is higher than in the medium which it is quitting. For the very same reason the radio beam, mounting from the lower atmosphere to the ionosphere, is refracted away from the vertical.

Contrast, in figure 10, the beams AOA' and BOB'. Below the boundary they differ in their inclination to the vertical; above, the difference is greater, because of the law of refraction (Snell's law of sines). If we go on making the incident beam more and more slanting, we come eventually to one which is refracted into the horizontal plane: it is COC' in the sketch. Any beam of still more slanting incidence will not be able to enter the upper medium at all; perforce it will suffer "total reflection." The direction CO may be regarded as the dividing line between the rays which can get through into the upper medium, and those which definitely cannot. The angle $C'OZ'$ is a critical angle of incidence.

The critical angle of incidence depends on the ratio of the wave speeds in the media. When these are water and air there is very little we can do to alter the speeds or their ratio. Let us, however, imagine ourselves possessed of some technique for altering wave speed ad libitum, and using it to make the speed in the upper medium increase without limit. As it increases, the critical direction will turn more and more toward the normal to the boundary. The beams which can pass through will be restricted to a smaller and smaller compass. If the critical direction arrives at the vertical, none at all will be able to pass through: even the normally incident waves will suffer total reflection.

Well, when the wave speed in the upper medium becomes infinite, the critical direction *does* arrive at the vertical! This is what happens when N rises to the value $\pi mf^2/e^2$. *Total reflection of the waves becomes unavoidable even for vertical incidence when the condition*

$$N \geqq \pi mf^2/e^2 \tag{3}$$

is fulfilled. Or, to turn the equation around: Penetration of the medium by the waves is possible when and only when the condition

$$f \geqq \sqrt{Ne^2/\pi m} \tag{4}$$

is fulfilled.

Leaving out the inequality sign from either formula 3 or 4, we have the *equation for the penetration frequency*, $f=\sqrt{Ne^2/\pi m}$ the relation between mirror density and wave frequency at which I have so long been hinting. As the manner of its derivation has now made evident, it refers to *vertically rising* waves. These are mainly used in the experiments for sounding the ionosphere, as one may say. But if the wireless is being used for communication over broad distances, it is the case of obliquely rising waves which occurs. For these the mirror density is reduced, in a manner easy to work out—though not so easy as it would be if the earth were flat; for actually the ionosphere follows the curvature of the earth, and this must be taken into account.

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[3] Actually Maxwell's theorem does refer to the amplitudes of the currents—but if the currents are not exactly 0 or 180 degrees apart in phase, the amplitude of one must be taken as a complex quantity.

[4] When u depends on f in the manner of equation 2, the group speed (which is an approximation to the signal speed) is equal to c^2/u. By a strange but quite fortuitous coincidence this is similar to the relation prevailing between wave speed and group speed for the "de Broglie waves" associated with material particles.

What values of N are given by the data, interpreted with the aid of formula 3?

This is a question which it is not well to answer too precisely. One might say that whenever an echo is observed on a frequency f, there must exist somewhere in the ionosphere an electron-density N related to f by formula 3. This is probably too strong a statement. The literature is full of allusions to mystifying echoes, some at least of which indicate that often the electron density at a given altitude varies rapidly from place to place (so contradicting one of our basic assumptions). Also it is almost certain that many echoes are due to partial reflection (as distinguished from total) occurring where N is increasing rapidly with altitude though its mirror value is not reached.[5]

One does well therefore to start from a good clear (h', f) curve, such as those of the figures, and calculate the N values for important points along it. But which shall we consider the "important" points? Those corresponding to special altitudes, such as 100 and 200 kilometers or those corresponding to special frequencies, such as penetration frequencies or the top of the crinkle in the curve of figure 7? The latter is the general practice, and therefore I follow it. The N values about to be given are those corresponding to presumptive maxima along the "curve of inference" of figure 2, to gaps or crinkles in the "curves of data." They are those of what I will call the "crowns" of the various layers (not the "tops," since there is no reason for supposing that the electron density falls suddenly to zero just above the points where it passes through maxima).

At Huancayo in the Peruvian Andes, then at a typical summer noon, N has the values $1.8\cdot10^5$—$3.3\cdot10^5$—$1\cdot10^6$ at the crowns of the layers lettered E, F_1 and F_2; so says Berkner. At Slough near London, at noon on a certain day of early spring (1933) Appleton found $1.2\cdot10^5$ at the crown of E and $3.8\cdot10^5$ at the crown of F, the F layer being at that time and place not differentiated into F_1 and F_2. These figures are not far apart, if E be compared with E and F_1 with F; but with a little search I could have found plenty of values differing much more greatly, as is attested by figures 9 and 11.

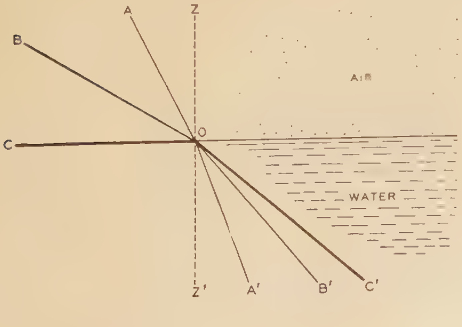
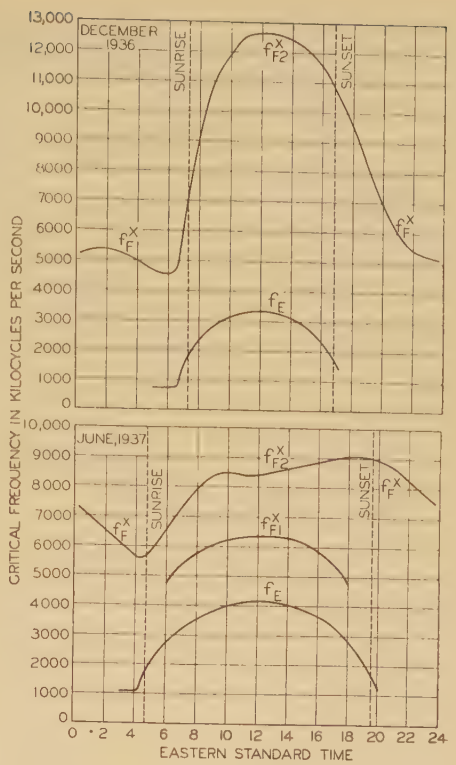


Figure 10. Diagram illustrating refraction and total reflection

Figure 11. Dependence of critical frequencies on season and hour of day (Smith, Gilliland, and Kirby)



From figure 9 we have already deduced that critical frequencies vary as the sunspot cycle proceeds; I now add that from minimum to maximum of the cycle just now ending, N at the crown of the E layer increased by three-fifths while N at the crown of F_2 went up (in winter) no less than fourfold!

From figure 11 we observe how great is the change of these N values with hour of day. True, the ordinates here are critical frequencies rather than values of N. The reader might convert them into N values; but the magnetic field of the earth is already intervening in these data and altering formula 3, and there is in fact another source of doubt;[6] so on the whole it is better to follow the slightly contradictory policies of regarding the critical frequencies as indications of electron density but of quoting them for themselves.

I therefore summarize, as precisely as seems justifiable: The N values at the crowns of the layers vary with hour of day and time of year and year of the sunspot cycle very markedly, and 10^5 to 10^6 electrons per cubic centimeter is a good figure to retain in mind for the order of magnitude thereof. As closing exhibit of this section I show figure

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[5] According to theory this should occur whenever N varies by a considerable percentage over a distance of the order of a wave length. Experiments show numerous instances of (h', f) curves in which the E branch extends for quite a way beyond the beginning of the F branch (e.g. figure 14; also figure 3 exhibits E and F echoes of the same signal). The occurrence of the E echo under such conditions is sometimes ascribed to partial reflection, sometimes to limited swarms or "clouds" of electrons which reflects portions of each signal while other portions slip between them and go on to the F region.

[6] I refer to the fact that there is no consensus of opinion as to whether the field acting upon each individual electron is truly $E_0 \sin nt$ as I wrote it on a preceding page, or is $E_0 \sin nt$ modified by a contribution due to the other oscillating electrons. This is a special case of one of the most frequent and difficult questions in physics (another special case being the question: What is the magnetic field within a magnetized body?). It would take much too much space to analyze or even to describe the arguments advanced: I will merely say that in the belief of some, the factor 3/2 should be multiplied into the right-hand member of (3).

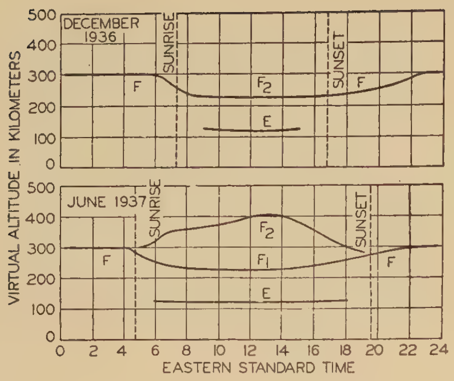

Figure 12. Dependence of virtual altitude of the crowns of the principal layers on season and hour of day (Smith, Gilliland, and Kirby)

13, in which the delay of the echo for a certain frequency (two megacycles) is plotted against the time during the hours preceding and following dawn. Interpret with the aid of figure 2 and the context thereof: During the night the E peak was too low to echo back the pulses of this frequency, which accordingly went farther and found their mirror in F; but at 6.35 a.m. sharply, the E peak attained to a height sufficient to intercept and return them. Or lest the distinction which I have been trying to make between "height" and "altitude" have slipped from memory, put it this way: During the night the electron density at the crown of the E layer was inferior to the mirror density for f = two megacycles, but during the dawn it was increasing and at 6.35 a.m. it reached and passed that mirror density.

Now to speak for a moment of altitude: Our procedure shall be as in the case of N—we regard virtual altitudes as indications of actual altitudes, but quote them for themselves. Figure 14 shows the virtual altitudes of the crowns of the layers, as they vary with hour of day in summer and winter, in the sky over Washington, D. C. It is evident that E is a fixture of the ionosphere at 120 kilometers or thereabouts, but F rises and falls in the course of a winter day, rises and falls and divides and merges again during a day of summer.

Now we must take brief notice of a difficult subject: the forkings and the doublings of the (h', f) curves, and the theory which finds their source in the earth's magnetic field.

A magnetic field, the earth's or any other, should have no effect whatsoever on radio waves so long as these are traveling in air composed entirely of neutral molecules. When, however, the waves are setting electrons into motion, the moving electrons are affected by the field, which has a twisting action on their paths. We have seen already that the moving electrons react, so to speak, upon the waves, raising the wave speed thereof. By altering the motions of the electrons, the magnetic field will influence at second hand the waves themselves. But will the result be perceptible? In view of the fact that the earth's magnetic field is very feeble by comparison with the fields between the poles of our electromagnets great or small, or even with those around the horseshoe magnets which are playthings, one might well think the influence not worth the trouble of computing. But those who first undertook to compute it—Nichols and Schelleng in America, Appleton independently in England, in the winter of 1924–25—found it a serious influence, and very well worth the trouble.

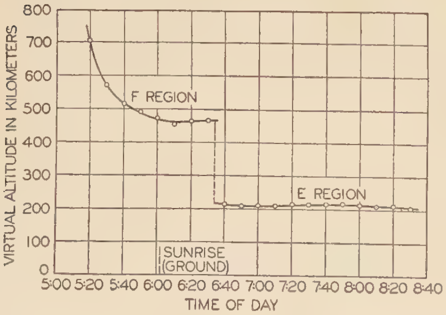

Figure 13. Ceiling for signal of fixed frequency shifting near sunrise from F to E as the electron density of the E layer increases with increase of light (Appleton)

The problem is one of those which are not very hard to state, but can be very tedious to solve except in special cases which may or may not be of practical importance. For this problem it happens that two of the special cases can be solved with relative ease, and one at least is realizable in practice. I cannot venture to give the theory of even this one, but at least I will attempt to describe what happens.

The special case occurs when the waves are traveling at right angles to the field. Since they travel vertically,[7] it is necessary to find a place on the earth where the field is horizontal. Such places are found in the equatorial regions only, and these are not precisely crowded with universities or engineering experiment stations. However the Carnegie Institution of Washington was inspired, several years ago, to set up a station in just such a place: Huancayo, in the Andes of Peru. Here they established long straight horizontal antennas, one running north and south, another east and west, and yet another northeast and southwest. In the waves which mount from these to the ionosphere and then come bouncing back, the electric field $E_0 \sin nt$—henceforth to be called "the electric vector"—is faithful to the direction of the antenna. They are called "plane-polarized waves."

When the north-south antenna is used, the electrons are impelled to and fro in the north-south direction which is that of the magnetic meridian. Now as is well known, an electron moving parallel to a magnetic field behaves just as it would if there were no such field at all. These waves ought therefore to behave according to the theory which we set up while we were still disregarding the magnetic field. They are the so-called "ordinary waves" or "*o* waves."

When the east-west antenna is used, the electrons of the ionosphere are impelled to and fro in the east-west direction, which is transverse to the earth's magnetic field. This is just the condition for the maximum amount of meddling by the field in the motion of the electrons. The meddling consists in bending the electron paths into curiously twisted arcs. The result is singular, and quite contrary to what one's intuition says, or at any rate, contrary to what my intuition told me. *The action of the magnetic field is tantamount to strengthening the electron-current density* I_e *parallel to the electric vector.* It will be recalled

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[7] In addition to the other advantages of sending the waves up vertically there is the feature that the angle between their line of motion and the field is the same when they are going up and when they are returning.

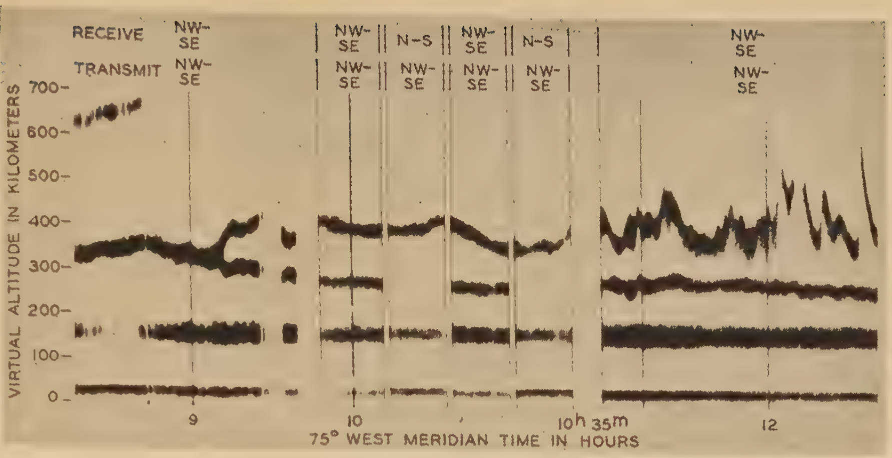

Figure 14. Echoes of plane-polarized signals (Wells and Berkner)

(from a preceding page) that it is I_e which for small N values cancels a part of the displacement current and so speeds up the waves, and for a certain critical N value cancels the whole of the displacement current and so brings about total reflection. So, for these "extraordinary waves" or "x waves," a given N value produces a greater augmentation of the wave speed, and the critical N value for total reflection is smaller than for the ordinary waves. The signal composed of x waves, mounting into the ionosphere, finds its appropriate mirror at a lesser altitude than does the signal composed of o waves, and it gets earlier back to earth. It may indeed come back from E while the o signal goes on to F or from F_1 while the o signal goes on to F_2, or from F_2 while the other goes irretrievably forth into space.

When the northwest-southwest antenna is used, the ionosphere takes charge of the signals, and separates them into an o component and an x component. Each travels according to its proper law, and the x component reaches its lower-down mirror earlier and beats the o component back to earth. Two echoes return instead of one. The earlier is plane-polarized with electric vector east and west, the laggard is plane-polarized with electric vector north and south. Suppose a long straight horizontal antenna is used to respond to the returning signals. It will respond to both, if pointed northwest-southeast; only to the earlier, if pointed east and west; only to the later, if pointed north and south.

All the foregoing were statements of theory at first, but thanks to the experiments of Wells and Berkner at Huancayo, they now are statements of data as well.[8] Figure 14 exhibits a small selection from the data.

Now look again at figure 4; formerly I asked the reader to ignore one of the curves, but now we will compare the two. The circles and the crosses indicate the o wave and the x wave, respectively. One is a fairly close copy of the other, shifted a certain distance along the horizontal axis. From the magnitude of the shift it is possible to compute the strength H of the earth's magnetic field; or let me rather say, it is possible to compute a numerical value which must agree with H, or else the theory will be vitiated. When the computation is made, the value turns out to be just a few per cent less than the field strength at ground level. The action of the field through the electrons on the waves is exercised only in the ionosphere, which is hundreds of kilometers up in the sky; and it is quite reasonable to believe that these few per cent are actually the falling-off in the field strength from the ground up to that level. Such is the present belief, and many of those who work in terrestrial magnetism are happy over the prospect of measuring thus the field in regions where there seems to be no greater hope of anyone ever actually going, than of going to the moon.

Actually figure 4 shows data obtained in England, which is far from the equator; I point this out in order to mention that even when the waves are traveling obliquely to the earth's magnetic field, there is a separation of the signals into pairs of echoes, and these are still amenable to theory. In this general case of oblique transmission, the waves are polarized elliptically—a feature difficult to visualize without a certain amount of specialized knowledge, but lending itself to some very neat and pretty experimental tests.[9] In the special case of transmission parallel to the magnetic field, waves initially plane-polarized should remain of this character but their plane of polarization should rotate as they proceed. There are indeed so many curious and interesting details of the influence of the field through the electrons on the waves, that a lecturer must be ruthless in ignoring them if he is to observe decent limits of time. I will mention only in closing that the "gyro-frequency" $eH/2\pi mc$—which in our latitudes (New York City) is around 1.3 megacycles—plays the part of a resonance frequency. Waves too close to this frequency are liable to great, not to say distressing, anomalies in transmission. Theoretical statements about waves in general are likely to assume two different forms, one appropriate to those of frequency higher and the other to those of frequency lower than the gyro-frequency. The statements made above as to the relative delays of o and x echoes refer to the former case, are to be reversed for the latter.

In figure 15 there appears something which, if the war had begun before its discovery, would perhaps have been called a "black-out." Being discovered however some years before the war, it was and is called a "fade-out." The apparatus was that which I mentioned previously in connection with figures 6–8; accordingly each of the pictures was traced in 15 minutes, and as soon as each was

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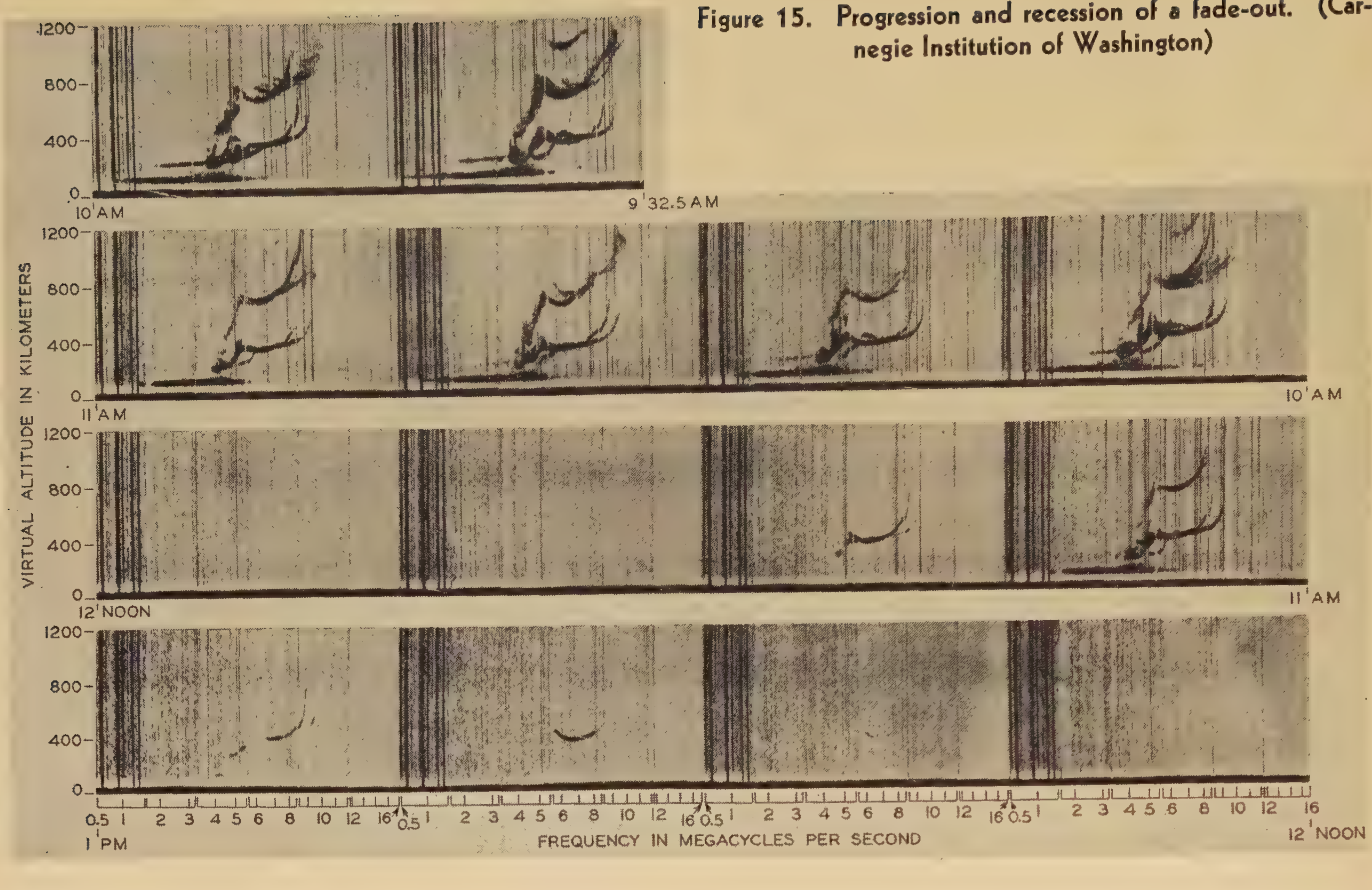
[8] This is a good place to speak of a question which may already have occurred to many readers, viz., the question why we assume the charged particles in the ionosphere to be free electrons rather than charged atoms or molecules. Were they of atomic or molecular mass, the separation of the o and x echoes would be inappreciable, and the "gyro-frequency", later to be mentioned, would be quite outside of the radio range. It is not, however, excluded that among the free electrons there may be a great multitude of charged atoms, perhaps even many times more numerous than they, though much less influential.

[9] It may perhaps be regarded as obvious that the ellipse of polarization should be described in opposite senses in the northern and southern hemispheres, since in one hemisphere the magnetic lines of force are coming out of the ground, in the other they are diving in. This inference was tested by a special experiment in Australia, and the result was taken as establishing the "magneto-ionic theory," as this general theory is often called.

Figure 15. Progression and recession of a fade-out. (Carnegie Institution of Washington)



finished the next was begun. See how the pattern of (h', f) curves, familiar and sharp in the earlier pictures, dissolves into fragments and then is completely wiped out! Later on it begins to come back piecemeal, and finally is restored as good as ever.

Since attention was focused on such events in 1935, they have been reported by the scores in every year, varying in duration and in severity. It requires no (h', f) curve to show them, since ordinarily they cut off communication by radio, and with the sharpness of a knife. Many an engineer, to quote from Dellinger, has "dissected his receiving equipment in the vain effort to determine why it suddenly went dead." Over broad areas the extinction is sudden and simultaneous in many fade-outs, more gradual in others; and restoration is as a rule more gradual.

Shall we interpret this strange and striking effect as a sudden vanishing of the ionosphere and all the reflecting layers thereof, or as a swallowing-up of the signals by something which is suddenly created underneath the ionosphere? Against the first suggestion it is to be said that no one can imagine anything which might so suddenly frighten all the electrons of the ionosphere back under cover, so to say—drive them into the arms of their parent molecules in a few seconds or minutes—when all day and even at night they manage to hold their freedom. Such a graph as figure 16 speaks also against it forcibly. Here in the upper part of the figure we see the critical frequencies[10] of F_2, F_1 and E as located every 15 minutes on (h', f) curves such as those of figure 6. Each flock of data lies along a curve which, intercepted though it is by the fade-out, resumes so nearly at the level where it left off that one can hardly believe that the ionosphere totally vanished in between.[11]

As for the curve marked "f_{MIN}" in figure 16, it represents the lowest frequency at which echoes are observed. I have said nothing as yet about there being such a minimum-frequency. How indeed can there be one, and why should signals of any frequency however low fail to be echoed, since the mirror density for any higher frequency is *a fortiori* more than a mirror density for any lower?

Attempting to supply an answer to this question, I point out that in such part of the theory as I have thus far given, there is nothing corresponding to *absorption*. This is because the electron current (I_e in the former notation) is in quadrature with the electric vector in the waves, being thus a "wattless current." This in turn is because we have assumed each electron to be entirely free, oscillating in the wave-swept ether as though there were nothing else in the world but itself and the waves. If, however, the electron were occasionally to strike and bounce off a molecule it would leave some (even though but a small part) of its kinetic energy behind, and this would have to be replenished by the waves. Indeed as soon as collisions are taken into account, the algebra tells us that the electron current is no longer in perfect quadrature with the electric vector. Dissipation of energy occurs together with reflection, and if it is sufficiently great—if, that is to say, the electrons collide often enough with molecules—it takes the place of reflection. In the terms of my acoustic simile on an earlier page, the signals are no longer echoed back from the hard slopes of the mountain range of figure 2*A*, but are swallowed up and lost as if in something soft and woolly.

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[10] For the ordinary waves, as indicated by the superscript in symbols such as $f^o{}_E$.

[11] In violent magnetic storms the ionosphere is so convulsed that the echoes lose their sharpness entirely, and (h', f) curves like those of figure 7 are replaced by broad smudges; or echoes may vanish altogether. These are quite different from fade-outs.

One would expect absorption to occur in the lower reaches of the ionosphere rather than in the upper, since the air is denser there and the electrons suffer many more collisions. The absorbing layer, that is to say, must be situated just where it is able to cut us off from the reflecting layers by dissipating the signals which we send. Why should it do so occasionally with such completeness, and most of the time not do so at all, for any except the lowest frequencies?

For an answer to this query, one looks again to the sun. Ordinarily, we will suppose, the ionizing agent coming from the sun penetrates deep enough into the air to form the reflecting layers high overhead, but is nearly consumed in so doing. Occasionally though the sun sends forth a quite abnormal transitory burst of radiation, so strangely constituted that it passes the reflecting layers without contributing to them or weakening itself, and continues so far down that at the level where it at last engenders free electrons they constitute a layer absorptive and not reflective. This would be no more than an *ad hoc* assumption, were it not that brilliant eruptions are frequently seen on the face of the sun at the moments when fade-outs are commencing. To some extent it is still an *ad hoc* assumption, for the light whereby the eruption is seen is certainly not ionizing light, and we must assume that the visible light is attended by rays of other wave lengths having just the properties desired. Coincidence of fade-out and eruption is, however, so frequent, that it would now take a very skeptical mind to reject the assumption. The trend of the curve "f_{MIN}" in figure 16 sustains it.

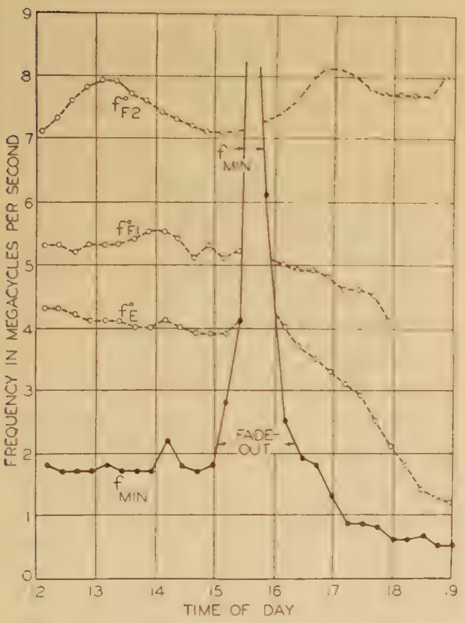


Figure 16. Trend of the critical frequencies and of the minimum echoed frequency as a fade-out proceeds (Berkner)

And so I have now come back to the theory that it is radiation from the sun which makes the upper atmosphere into an ionosphere, by detaching electrons incessantly from the molecules thereof. (The detaching must be incessant, for the electrons are always liable to recapture by the molecules.) Of this theory it may be said that the major facts confirm it, though at night the E ionization persists so tenaciously that we are obliged to seek for a separate agent (meteors, perhaps?), while numerous minor discrepancies can be explained away by making special assumptions which can neither be confirmed nor refuted because there is so little independent knowledge of the upper atmosphere—not a very satisfactory situation for the present, but at any rate one which offers endless promise!

Thus it can readily be seen that as the ionizing light descends from heaven through the upper air, the ionization per unit volume should at first increase (because the air is getting denser) and then decrease (because the light is getting to be used up). This offers an explanation for a layer; and the mathematical working out of the idea—due in the main to Chapman—shows that not only the existence but the shape of the peak in the curve of figure 2 is compatible with the theory. But there are several layers and peaks, not just one; how does this come about? Well, the atmosphere is a mixture of several gases, differently susceptible to the ionizing light; one can attribute a peak to each gas (indeed more than one to a gas, by invoking different states of the molecules). The height of a peak, the *N* value at the crown of a layer, should rise and fall as the sun rises and sinks in the sky. This is true of the layers E and F_1, as we saw from figure 12; and again there is a quantitative theory by Chapman, which is borne out in some though not in full detail. Of F_2 it is not always true, as figure 12 proclaims: There is a minimum at noon in summer, and the highest *N* values of all are attained in winter! One tries to cope with the discrepancy by assuming that as the sun climbs higher in the sky, the F_2 region expands so much in the heat that although the total number in the region is properly increasing, the number in unit volume suffers a decline. The layers do not disappear at night, though the *N* values shrink. There seems to be plenty of time for recapture of all the electrons between sunset and sunrise, and one is driven to hunt for other causes of ionization which emerge when the sunlight is gone.

The sunlight is therefore not the only, yet certainly the major factor in maintaining the ionosphere—not, however, any sunlight that we ever receive! This portion of the sun's outpourings is so thoroughly consumed that it never reaches down to the levels where we live. But if it did reach down, there might be no one living to report it; for it is the powerful and dangerous ultraviolet light, which when used in therapy must be used with so much care. If that of the sun were not exhausted in forming the ionosphere, it would probably be intense enough to be deadly. If the ionosphere were not formed and any being were to survive to play with wireless waves, he would find them escaping uselessly into space. So the lethal short waves of the sun are spent, not harmlessly merely but usefully, in erecting a barrier to keep the long waves of the wireless pent up within the lower atmosphere where they can be of value.

Of Current Interest

Other Societies •

SPEE Reports Engineering Education Progress

The record of significant trends, developments, and events in engineering education is continued in the fifth annual progress report of the Society for the Promotion of Engineering Education, released prior to its annual meeting, Berkeley, Calif., June 24–28, 1940, by Professor C. F. Scott (A'92, F'25, HM'29) chairman of the committee on 1939 progress report. The report is based upon about 60 letters from officers and chairmen of the society.

Enrolment shows an increase of nearly 30 per cent in three years. Undergraduate students in approximately 150 engineering schools in the United States and Canada today number about 106,000. Candidates for the master's degree number more than 4,700, and for the doctor's degree 850, both more than doubled in three years. The report ascribes this increase "partly to the employment situation but mainly to the growing regard for engineering training as a preparation for careers in industry, business, and public service." Greatest increase in enrolment during this period, 89 per cent, was in mechanical engineering and "may be traced to the character of this curriculum and to the recent publicity given to aeronautics, Diesel engines, and air-conditioning. Most mechanical-engineering curricula stress management and labor problems, which may be an added explanation."

Chemical engineering, the report indicates, is maturing rapidly, and becoming more and more a mathematical, quantitative kind of engineering; its technical literature is growing; the quality of instruction and the physical facilities of the schools are improving; and a younger generation of teachers is putting it across. Advances being made by engineering schools in the teaching of physics, English, aeronautics, surveying, geodesy, mathematics, hydraulics, and fluid mechanics, are also indicated.

On the subject of research, the committee quotes a statement to the effect that "prior to 1933 over half of new-process and new product development came from Central Europe; in 1938, less than five per cent. Totalitarian influence on education is forcing American industry to a new dependence on research 'made in U.S.A.' The war in Europe may have an important influence here in the transplanting of refugee scholars."

SPEE's committee on aims and scope of engineering curricula in its contribution to the report stresses the fact that the normal basic course should prepare engineers for a wide range of technical, administrative, and executive responsibilities. Some of the views it has considered are: (*a*) the lengthening of the undergraduate curriculum to five or six years, (*b*) requirement of a period of preliminary study in a school of liberal arts preceding admission to the school of engineering, and (*c*) the trend toward dividing the curriculum in the junior and senior stages.

The past year brought to completion the second stage in the accrediting program of the committee on engineering schools of the engineers' council for Professional Development of which SPEE is a member body. In the first stage, the program of inspection was organized and principles and procedures were developed, which have now been put into operation. Today an essentially complete list of accredited curricula of the engineering schools of the country is available for the guidance and use of state licensing boards for engineers, the national engineering societies, and the thousands of high-school students contemplating an engineering career. The interchange of information also has given opportunity for all schools to improve their educational programs.

Future Meetings of Other Societies

American Chemical Society. Fall meeting, September 9–13, 1940, Detroit, Mich.

American Gas Association. October 7–10, 1940, Atlantic City, N. J.

American Institute of Mining and Metallurgical Engineers. Regional meeting, September 10–13, Salt Lake City, Utah.

American Society of Civil Engineers. Annual convention, July 24–26, 1940, Denver, Colo.

American Society of Mechanical Engineers. Fall meeting, September 3–6, 1940, Spokane, Wash.

American Transit Association. 59th annual convention, September 23–26, 1940, White Sulphur Springs, W. Va.

Engineers' Council for Professional Development. Annual meeting, October 24, 1940, Pittsburgh, Pa.

Illuminating Engineering Society. 34th annual convention, September 9–12, 1940, Spring Lake, N. J.

National Safety Council. October 7–11, 1940, Chicago, Ill.

Employment Service Incorporates; Opens New Regional Office

The employment service maintained jointly by the four founder engineering societies has been incorporated in New York State and its name changed to Engineering Societies Personnel Service, Inc. The move was made to satisfy legal requirements in some of the states in which the service operates. Officers of the corporation are: George T. Seabury, president; C. E. Davies, vice-president; O. E. Hovey, treasurer; A. H. Meyer, secretary. The present staff will continue with the corporation.

To meet the increased demand for engineers, the Engineering Societies Personnel Service, Inc., has been requested to open a fourth regional office in Detroit, Mich., in addition to those already operating in New York, N. Y., Chicago, Ill., and San Francisco, Calif. A survey of the situation and preliminary arrangements were made by a special committee, representing the founder societies and the Engineering Society of Detroit. R. E. Greene (A'26), Detroit Edison Company, is the AIEE representative on the committee, which will act as an advisory board to the Detroit office. Louis E. Williams is manager of the new office, which expects to open about July 1, 1940.

Resuscitation Review Board Appointed

Appointment of a board whose objective will be to make further study of the effects of electric shock, the possibilities of resuscitation under varying conditions, and the comparative effectiveness of resuscitation procedure has been announced by the accident prevention committee of the Edison Electric Institute.

The Resuscitation Review Board will receive reports on cases of electric shock from various sources, particularly members of EEI technical committees, electrical associations, and the National Safety Council. Utility companies are being urged to co-operate by reporting cases.

Among those appointed to serve on the board are: W. B. Kouwenhoven (A'06, F'34), dean of engineering, Johns Hopkins University, Baltimore, Md.; E. W. Oesterreich (A'21, M'25) general superintendent of distribution, Duquesne Light Company, Pittsburgh, Pa.; Wills Maclachlan (A'08, F'21) consulting engineer, Toronto, Can.; A. B. Campbell (A'20, F'38) engineer, EEI, New York, N. Y., and secretary, accident prevention committee; W. R. Smith (M'13, F'30) safety engineer, Public Service Electric and Gas Company, Newark, N. J., and chairman, accident prevention committee.

Heating and Ventilating Guide for 1940. Enlarged in scope, but "streamlined" and reduced conveniently in bulk, is the new (18th) edition of the American Society of Heating and Ventilating Engineers' "Heating, Ventilating, and Air Conditioning Guide for 1940." Consistent with its policy, the society still is effectively following and helpfully reflecting the increasing wealth of experience and technical data in a rapidly and constantly expanding field. The physical bulk of the new volume has been reduced in part by elimination of repetition of material, by some consolidation in material, and by the use of thinner paper. As usual, the volume contains three sections: technical data, catalog data, and society roster. The volume is 6 by 9 inches in size, $1^7/_8$ inches thick, and contains a grand total of 1,207 pages. It is available at $5.00 per volume from the ASHVE, 50 Madison Avenue, New York, N. Y.

Industrial Control Standards. The National Electrical Manufacturers Association has recently issued its "Industrial Control Standards", a compilation of information on the manufacture, test, and performance of industrial control equipment that represents standard practice in the United States. Copies of the publication, which contains 77 pages, may be obtained at $1.00 each from NEMA, 155 East 44th Street, New York, N. Y.

From AEC • •

ITEMS appearing under this heading are from the news service of American Engineering Council.

FCC Acts on Television and Frequency Modulation

After several weeks of deliberation the Federal Communications Commission has decided, for the time being at least, to stand by its contested action in refusing to permit television programs on a commercial basis pending further progress in the art. It indicated its willingness, however, to permit the further expansion of experimental television broadcasting in order that different systems now competing may demonstrate their advantages under comparable conditions. Experimental stations are now operating in New York City and Los Angeles, and applications are pending for new stations in New York City, Albany, Boston, Washington, Cincinnati, Los Angeles, and San Francisco. The Commission indicated its intention to act immediately upon these, and its readiness to entertain new applications from responsible experimenters to the extent of the limited number of wave-bands available.

In making its decision the Commission found that the major part of the industry now takes the view that a premature "freezing" of standards would hamper technical research leading to greater efficiency. As soon as the industry itself can agree upon any one of a number of competing standards, "the Commission will consider the authorization of full commercialization."

In the audible broadcasting field, the Commission acted to set aside 40 channels for both commercial and educational broadcasting by the frequency-modulation system, which it characterized as "one of the most significant contributions to radio in recent years", and which is "ready to move forward on a broad scale and on a full commercial basis." The new system requires a different type of broadcasting and receiving equipment, but because its range is now limited to an effective distance of from 40 to 60 miles is expected to find its principal field of usefulness in urban areas.

Consideration of these two problems has delayed the general shift in the assigned wave lengths of existing stations to reduce interference, which was scheduled to take place this summer, but will now be deferred until late in 1940.

United States Rushes $5,000,000,000 Defense Program

Germany's startling successes with her new kind of mechanized warfare during the past month have awakened the United States to one of its periodic realizations that its defenses are entirely inadequate, with the result that rush legislation is currently being passed to provide nearly $5,000,000,000 to expand the personnel, equipment, and facilities of the Army and Navy, and the civil production facilities necessary to accomplish this task.

In justice to the present Administration the fact should be pointed out that it has been as liberal with the defense establishment as was consonant with public opinion, even to the point of incurring considerable criticism for the extent to which it has allocated emergency expenditures for military purposes. Responsibility for the present inadequacy must be laid, not to any group or class, but to public sentiment as a whole. In this neglect the United States is not alone, as is evidenced by the succession of European nations that have found themselves virtually helpless in the face of new methods of mechanized warfare, even though most of them were better prepared than is the United States at this time.

No one can state with authority, of course, that the totalitarian powers will be victorious over Great Britain and France or that, in such an event, they will attack this country. But events of the past few months have repeatedly demonstrated the fact that the desire to remain neutral is no insurance against invasion, and it is the essential business of any nation to prepare itself to meet possible contingencies, even though they may be considered remote.

The current preparedness drive was initiated by a message to Congress delivered personally by President Roosevelt on May 16, in which he asked for the immediate appropriation of $896,000,000, in addition to contract authorizations to be met from later appropriations of $286,000,000, for the expansion of the Army, Navy, and Marine Corps. As reports from Europe became more and more serious these amounts were subsequently stepped up until they reached a total of $4,672,011,352, with no assurance that the end is in sight. This is equivalent to three-quarters of the amount spent for military purposes by this country during the first fiscal year of the World War.

The complexities and ramifications of the proposed program are too complex to be presented here in detail. Among the more significant items are the procurement of full equipment for an army of 1,000,000 men, as compared with a present strength of 230,000; major increases in the number of vessels and personnel of the Navy, and expansion of the air forces. In addition, it is desired to step up facilities for aircraft manufacture to a potential capacity of 50,000 planes per year, as compared with present estimates of 12,000, and to train large numbers of pilots and mechanics. Included in the Army equipment orders will be large quantities of mechanized units, including tanks, trucks, antiaircraft and antitank guns, fire-control equipment, and similar material. Also planned are many new air bases, training stations, and other facilities to care for the increases in personnel and equipment.

To finance these large expenditures Congress has under consideration measures to expand the present debt limit of the government and to increase taxes. Details are still unsettled, but it appears probable that income-tax rates will be increased to the order of ten per cent, income-tax exemptions may be lowered, and excise taxes on many items, such as liquor, tobacco, gasoline, and other commodities, may be increased.

ECONOMIC EFFECTS

A program on so large a scale, requiring the adjustment of private industry to many entirely new products, is sure to have innumerable repercussions. In some lines of industry these will be minor, while in others large problems will arise. Perhaps the three fields most directly affected are the aviation, shipbuilding, and machine-tool industries, already strained to capacity and now facing the need to step up production even more. All three face the immediate necessity of greatly expanding plant capacity and personnel.

Steps already taken in the aviation industry serve to illustrate the complexity of the problems involved. Already hard at work on rush orders for military aircraft for foreign buyers, this group faces the necessity of quickly expanding its rate of production from the present level of 12,000 planes per year to a new goal of 50,000. Leaders of the industry have already been called to Washington to discuss ways and means.

Such new plants as are necessary will be built, with the Government evidencing a strong desire to have them located between the Allegheny and Rocky Mountains, so as to be protected from attack. Government aid in financing expansion will be made available, either through the Reconstruction Finance Corporation or otherwise. In order to make the most effective use of existing plants, steps have already been initiated to pool American patents and to acquire those held abroad—the Government, for example, has received a license to manufacture the Rolls Royce 12-cylinder liquid-cooled motor used in Britain's fastest ships.

Studies are under way leading to the standardization of orders in a few selected types of planes, each of which will be manufactured in a number of factories. The same procedure will be followed in stepping up airplane-motor production, currently the "bottle-neck" in military plane output. A committee has been formed to study available types and select those that will be adopted.

Consideration is being given to converting some of the surplus automobile-manufacturing capacity to airplane motors. A shortage of tool- and die-makers is anticipated and if it develops the auto manufacturers may be asked to forego their usual annual practice of announcing new models for 1942 (1941 model changes are already well advanced and will not be interfered with). Glenn L. Martin estimates that it now requires from 350 to 400 man-hours to produce a small plane, and the amazing total of 14,000 man-hours to turn out a large bomber, as compared with 218 hours for the standard low-priced motor car. Studies are being made to adopt more mass-production methods and cut down this labor requirement.

DEFENSE BOARD APPOINTED

The number and magnitude of the problems that must be solved to render the defense program a reality prompted President Roosevelt on May 28 to create a commission of seven members to plan and co-ordinate the efforts of the many participants who must take part in this effort. The members, and their respective responsibilities, are:

Edward R. Stettinius, Jr., who resigned as chairman of the board of the United States Steel Corporation to supervise the orderly production and delivery of needed raw materials.

William S. Knudsen, given a leave of absence from his position as president of General Motors to direct industrial manufacture.

Sidney Hillman, president of the Amalgamated Clothing Workers Union, placed in charge of personnel problems, including the training of additional workers.

Chester C. Davis, member of the Federal Reserve Board, to take care of problems relating to agriculture.

Ralph Budd, chairman of the Chicago, Burlington and Quincy Railroad, to co-ordinate transportation and secure prompt delivery of raw materials and finished goods.

Leon Henderson, member of the Securities and Exchange Commission, to keep a check on industrial price trends, particularly as regards raw materials.

Miss Harriet Elliott, dean of women, University of North Carolina, to protect consumers.

While no specific authority was granted to this board to enforce its decisions and policies, the President is clearly determined to give it any necessary backing in preventing the defense program from becoming a mad scramble and causing unnecessary economic disruptions.

EFFECTS ON LABOR

Statements of the CIO, the AF of L, and the Bureau of Labor Statistics agree on the conclusion that an adequate supply of skilled labor is available, although some shortages will undoubtedly occur in specific localities. The United States Employment Office is already taking steps to transfer workers from points where there is a surplus to meet such conditions.

Many government officials, however, anticipate shortages in certain trades and a plan has been proposed for training courses to enroll a million young men from the NYA, CCC, and civilian life for noncombatant service. The Civil Aeronautics Authority is proceeding with a program to start July 1 for the enrollment of 50,000 young men in primary flying courses, as well as several thousands of others with aviation experience to take advanced courses. Because of the high standards of military aviation, it is estimated that only ten per cent of these will become suitable for combat flying. To maintain a fleet of 50,000 planes is estimated to require from 100,000 to 150,000 expert pilots, in addition to 500,000 ground personnel, the majority of whom must be highly trained technicians. The Army now has only 3,700 active and 2,000 reserve pilots; the Navy, while not announcing the number of its pilots, has a total air personnel of less than 5,000. The Navy's shipbuilding program alone will give employment to 50,000 men in addition to those currently working in yards. Altogether, it is clear that many new and expanded avenues for employment will be opened up by the preparedness program.

OTHER ANGLES OF THE PROGRAM

Among the many new developments springing from this sudden activity may be mentioned the decision of the Civil Service Commission to go on a 24-hour basis in order to meet promptly the calls for additional personnel; the reversal by the House of Representatives of its previous decision to postpone the construction of a third set of locks for the Panama Canal; the announcement by the Federal Works Agency that its personnel records of furloughed engineers will be made available to private employers needing such help to speed up production; and the transmission by President Roosevelt of Reorganization Plan V, transferring the Immigration Service from the Department of Labor to the Department of Justice.

Industry • • • •

Photoelectric Phonograph

Reproduction of sound from records through the use of the photoelectric cell has been accomplished in a new phonograph developed by the Philco Corporation and recently demonstrated at Chicago, Ill. Constituting the first basic change in the principles of phonographic reproduction since Edison's original invention, the new process is declared by the company to provide notable improvement in tone quality and range of reproduction and a tremendous extension of the life of records.

In the new phonograph, the needle, whose forced vibrations reproduce the variations recorded in the grooves of the revolving record, has been replaced by a sapphire jewel that floats through the grooves, transmitting the tone vibrations to a tiny mirror swinging freely on an axis. A beam of light produced by a small bulb and directed at the mirror picks up the vibrations and reflects them on a photoelectric cell, which converts them into electric currents to be amplified and reproduced as sound. The floating jewel thus acts merely as a control valve to operate the photoelectric cell. A steady flow of light for the bulb is provided by an oscillator by which 60-cycle alternating current is transformed into high-frequency current of 1,800,000 cycles. The bulb, specially designed, is filled with argon.

Replacing the needle with a floating jewel virtually eliminates wear on records, greatly increasing their life. The jewel is stated to have a life of eight to ten years.

A. E. Morgan, former chairman and chief engineer of the Tennessee Valley Authority, has returned to the presidency of the Dayton-Morgan Engineering Company, from which position he resigned in 1933 to go with the TVA. The company has recently been reorganized and has moved its offices from Dayton to Yellow Springs, Ohio.

Letters to the Editor • • •

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

A Modern Aspect of Engineering Education

To the Editor:

The problem cited in the article on page 119 in the March issue of ELECTRICAL ENGINEERING, has been of major interest to business executives, educational authorities, and the students themselves, for many years past, as well as a theme of considerable anxiety and thought for parents.

One of the points that seems to confuse the minds of the younger generation, both students and graduates, is the uncertainty of objectives; they seem not to know where to look for authoritative guidance.

In your issue of reference, Doctor Torchio on page 101 deprecated the decision of the United States utilities to adhere to Edison's original voltage, nominally 110, and mentions the advantages of a nominal voltage of 220, such as is currently used in Europe and countries subject to Continental influence.

In the *Journal* of The Institution of Electrical Engineers, London, January 1940, page 25, an English engineer states that he regrets the English necessity for adhering to standards of a nominal 220 volts, and details with considerable emphasis the disadvantages thereof.

On page 62 of the same issue another engineer mentions the growing need in England of high tension transformer supply paralleling the low tension mains. This latter practice closely parallels the United States practice of installing small transformers at long intervals for light load areas and decreasing the transformer spacing as the load grows.

Having maintained a large number of contacts with engineers in the United States and abroad, I have found this general matter of voltage the subject of many acrimonious discussions with my friends and acquaintances. From them I have gathered that there seems to be little doubt that a 220/380 volt installation is cheaper in the beginning, but because of the smaller conductors used is likely to be flimsy. At any rate, and in spite of many efforts, I have not been able to ascertain with any degree of exactitude comparable costs based on area, distance, and load.

In any case, outside of certain areas in Canada, Switzerland, and Scandinavia, where especially favorable rate conditions prevail, the voltage standards used in the United States have caused or permitted more widespread use and a greater degree of convenience and safety than I have observed anywhere else in my rather extensive travels.

What I have in mind is that perhaps the Edison Electric Institute or the National Electrical Manufacturers' Association, or the Federal Government can compile a list of nationally recognized needs that could form the subject of concrete study and effort. I simply picked up this glaring difference of opinion because it was handy, but to anyone reading the current technical press, many such examples become evident every month.

Best regards from Chile.

A. J. Noerager (A'11)

(Chief Electrical Engineer, Braden Copper Company, Rancagua, Chile)

"Reciprocal Addition"

To the Editor:

Mr. Blade's letter on "Reciprocal Addition" (*EE, June '40, p. 246*) is interesting from a mathematical point of view. But when the parallel resistors or the series capacitors are of values that do not lend themselves to easy calculation for least common denominators or numerators, both the conductance and the "reciprocal addition" method are cumbersome.

Why not dispense with fractions altogether? Use decimals. The use of the reciprocal scale on the slide rule will make these calculations extremely simple.

Take five parallel resistor elements of, say, 3 4, 7, 11, and 13 ohms. The equivalent resistance

$$R=\frac{1}{\frac{1}{3}+\frac{1}{4}+\frac{1}{7}+\frac{1}{11}+\frac{1}{13}}$$

or

$$R=\text{recip}(\text{recip } 3+\text{recip } 4+\text{recip } 7+\text{recip } 11+\text{recip } 13)$$

$$R=\text{recip}(0.333+0.250+0.143+0.091+0.077)=\text{recip } 0.894$$

$$R=1.12 \text{ ohms}$$

Sanford Hershfield (Enrolled Student)

(Cooper Union Institute of Technology, New York, N. Y.)

Federal Water Power and Electrochemical Industries

To the Editor:

I read with a great deal of interest Doctor Fink's article in the February 1940 issue of Electrical Engineering. It certainly indicated a bright future for the electrochemical industries.

However, my sense of engineering justice based on the supreme law of the conservation of energy urged me to draw attention to Doctor Fink's statement concerning the huge power development possibilities at Victoria Falls in Rhodesia, Africa. He quoted the volume of water as "20 to 60 million gallons daily" (presumably imperial gallons). According to all information that I have been able to locate, the height of these falls is approximately 400 feet.

The application of a little mathematics, using the maximum total flow, gives a figure of 3,770 kw possible.

Therefore from Doctor Fink's own figures, I would conclude that the 4,000-kw installation now in operation (presumably) at Victoria Falls, has not only "scratched the surface" but made a lasting impression upon it.

R. F. Cline (A'37)

(Norton Abrasives, Chippawa, Ontario, Canada)

Editor's Note: Because various consular offices and information bureaus could not supply information regarding the flow of the Zambesi River over Victoria Falls, and because reference to encyclopedias and other supposedly authoritative published material yielded widely varying figures, a request for information was addressed to the director of publicity at Salisbury, Southern Rhodesia; his reply follows:

To the Editor:

I have to acknowledge with thanks receipt of your letter of 14th March 1940. In regard to your questions, the following information will be of use to you.

Highest maximum flow of water over Falls (April 1934)	165,000,000 gallons per minute
Mean maximum flow of water over Falls, flood season	120,000,000 gallons per minute
Lowest minimum flow of water over Falls (October 1924)	6,500,000 gallons per minute
Mean annual flow of water over Falls	47,000,000 gallons per minute
Average height of Falls	352 feet

I am afraid I cannot tell you anything about the estimated horsepower that could be developed at the Victoria Falls if all the water was to be used for power purposes, but no doubt you will be able to work that out for yourself from the data given.

E. C. Alderson

(Director of Publicity, Salisbury, Southern Rhodesia)

Books Received •

"Playing With Lightning." This new book by Karl B. McEachron (F'37) and Kenneth G. Patrick is a biography of lightning with technical terms held down to a minimum, yet with scientific accuracy. The study of lightning is traced from early observations to the present-day artificial-lightning generators in laboratories, and photographic and electrical equipment for "fingerprinting" natural lightning. Chapters are devoted to some case histories to illustrate unusual pranks played by lightning, to a discussion of the value of lightning rods, and to answers to some of the most popular questions regarding lightning, such as "Where is the safest place in the home during a storm?" The book contains more than 200 pages, with 16 illustrations, and is published by Random House, New York, N. Y.; the price is $2.50.

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ENGINEERING REORGANIZATION. By J. J. Gillespie, with a foreword by D. Brown. Pitman Publishing Corporation, New York, 1940. 268 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $4.00. For engineering companies not engaged on continuous or mass production. Planning, material and quality control, time study and job analysis, costing and sales methods are discussed, with specific examples and applications.

FUNDAMENTAL PRINCIPLES OF ELECTRIC AND MAGNETIC CIRCUITS. By F. A. Fish. Third Edition. McGraw-Hill Book Company, New York and London, 1940. 229 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $3.00. Intended for undergraduates as an introduction to the study of electric-power machinery and transmission. This edition partly rewritten; some new material.

MODERN ELECTRIC AND GAS REFRIGERATION. By A. D. Althouse and C. H. Turnquist. Third revised and enlarged edition. Goodheart-Willcox Company, Chicago, 1939. 858 pages, illustrated, 8 by 5 inches, leather, $5.00. For school and home use, covers both domestic and commercial refrigeration. Fundamental physical principles, installation, servicing, refrigerants, and air conditioning are treated. Domestic refrigerator specifications are given. Review questions with answers.

EINFÜHRUNG IN DIE THEORETISCHE ELEKTROTECHNIK. By K. Küpfmüller. Second enlarged edition. Julius Springer, Berlin, 1939. 343 pages, diagrams, etc., 10 by $6^1/_2$ inches, cloth, 19.80 rm. Introduction to the theory of electrical engineering, intended to fill a place between elementary texts and treatises upon specific applications. Includes essential physical laws and the facts and methods which the electrical engineer requires as a general background.

THE PHILOSOPHY OF PHYSICAL SCIENCE (Tarner Lectures 1938). By Sir A. Eddington. The University Press, Cambridge, England; The Macmillan Company, New York, 1939. 230 pages, 9 by 6 inches, cloth, $2.50. Examines the nature of physical knowledge and demonstrates its application to the physical universe. The two final chapters present an outline of a general philosophical outlook which the author believes a scientist can accept without inconsistency.

A PRIMER OF TIME STUDY. By F. W. Shumard. McGraw-Hill Book Company, New York and London, 1940. 519 pages, illustrated, 9 by 6 inches, cloth, $5.00. Based on the use of the stop watch as a means of establishing standard time and energy values for machines and men. Piecework, premium, and group-incentive plans are treated. Examples and test questions.

AMERICAN PLANNING AND CIVIC ANNUAL. Edited by H. James. American Planning and Civic Association, Washington, D. C., 1939. 288 pages, illustrated, 9 by 6 inches, cloth, $3.00. The papers included in this volume have been presented at various national and regional conferences, and are grouped under the headings of community reclamation, industrial migration, man-made obstacles to planning, rural problems, national income, public works, state and national parks. They constitute a survey of current work.

ELECTRODYNAMICS. By L. Page and N. I. Adams. D. Van Nostrand Company, New York, 1940. 506 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $6.50. Advanced treatment of the theoretical aspects of electrodynamics, covering the electromagnetic field, energy, stress, momentum, wave motion, radiation, three-dimensional and four-dimensional vector analysis, and the principle of relativity.

THE STORY OF THE LAMP AND THE CANDLE. By F. W. Robins. Oxford University Press, London, New York, and Toronto, 1939. 155 pages, illustrated, 10 by $7^1/_2$ inches, cloth, $5.00. The history of lighting methods from the earliest times to the advent of electricity. Deals fully with the torch, candle, and various types of lamps, but touches only briefly upon gas lighting.

Institute Activities

Pacific Coast Convention Will Combine Technical and Recreational Features

A PROGRAM of technical sessions including a special student session, varied inspection trips, social and sports events, has been arranged for the 1940 Pacific Coast convention, to be held at Los Angeles, Calif., August 27–30. As convention headquarters, the Ambassador Hotel has many advantages. Conveniently near the Los Angeles shopping district, it has 22 acres of grounds, with excellent outdoor swimming pool, pitch and putt golf course, tennis courts, and other facilities including its widely known Cocoanut Grove.

VACATION OPPORTUNITIES

Southern California is famous for its numerous vacation spots. Its proximity to the mountains and sea offers vacation possibilities to satisfy the most exacting. Among varied points of interest in and around Los Angeles are: Huntington Art Galleries and Gardens, San Juan Capistrano and other missions, Palomar Mountain, where the 200-inch telescope is located, California Institute of Technology, where the 200-inch mirror is being prepared, Gay's Lion Farm (200 lions), and others. Those attending the convention should not lose sight of the opportunity of visiting the Golden Gate International Exposition at San Francisco either before or after the meeting.

Schedule of Events

Tuesday, August 27

9:00 a.m.	Registration
10:00 a.m.	Opening of convention and address of welcome by N. B. Hinson, convention chairman
10:15 a.m.	Address by President-Elect Sorensen
10:45 a.m.	Address by Douglas Shearer
2:00 p.m.	Session on protective devices
5:30 p.m.	President's informal reception
7:00 p.m.	Student-counselor dinner and conference
7:30 p.m.	Trip to Planetarium

Wednesday, August 28

9:00 a.m.	Session on power transmission and distribution
9:00 a.m.	Conference on governors, frequency control, and load swings
2:00 p.m.	Session on electrical machinery
2:00 p.m.	Session on instruments, measurements, and basic sciences
2:00 p.m.	Student technical session
9:00 p.m.	Dinner, dancing, Cocoanut Grove

Thursday, August 29

9:00 a.m.	Communications session, joint with Institute of Radio Engineers
2:00 p.m.	Golf tournament at the Riviera Country Club
2:00 p.m.	Student technical session
7:00 p.m.	Buffet dinner, dance, and presentation of sports prizes, Riviera Country Club

Friday, August 30

Inspection trips: trips to points of interest in and around Los Angeles

Members proposing to attend the convention, who would like advice on planning vacation schedules, may obtain full information by writing to O. W. Holden, chairman of the inspection trips committee, at 207 South Broadway, Los Angeles, Calif.

TECHNICAL SESSIONS

The opening session of the convention will be addressed by President-Elect R. W. Sorensen on the subject "Science and Superstition." An address will be presented by Douglas Shearer, sound director of Metro-Goldwyn-Mayer Studios, whose talk is expected to be of great interest.

Five technical sessions and one technical conference are tentatively scheduled. Four of the five technical sessions will consist of papers and discussions, and the fifth will be a joint meeting with the Institute of Radio Engineers who are holding their convention at the same time. A nationally known speaker will be present to address this session.

The technical conference, one of the high lights of the technical program, will deal with the subject of governors, frequency control, and load swings, with several leading engineers entering into the discussion.

The technical program is scheduled to be published in the August issue.

STUDENT ACTIVITIES

The student counselor dinner and joint conference on student activities will be held on Tuesday evening, the opening day of the convention. All student delegates and counselors as well as others interested are urged to attend.

Holding the student technical sessions on Wednesday and Thursday afternoons will enable students and others interested to take part in these discussions without missing many other important sessions of the convention. Students are invited to attend all the convention activities, including the technical sessions, entertainment, and inspection trips.

Among the papers to be presented by students are the following:

MEASUREMENT OF REACTIVE VOLT-AMPERES BY MEANS OF SYMMETRICAL COMPONENTS, **Charles B. Lee**, University of Washington

STABILIZED NEON-TUBE COUPLED AMPLIFIER, **W. H. Huggins**, Oregon State University

TWO-MILLION-VOLT IMPULSE GENERATOR, **W. R. Johnson**, Stanford University

IMPROVED-TYPE LOSSER MODULATOR, **V. S. Carson**, Stanford University

ONE-METER REPLICA GRATING SPECTROGRAPH, **J. Mitch**, Montana State University

PERMEANCE OF TAPERED SLOTS IN ELECTRICAL MACHINES, **T. C. Wang**, California Institute of Technology

ENTERTAINMENT

There should be no dull moments for anyone attending this convention since plenty of entertainment will be offered. An informal reception on Tuesday afternoon provides an opportunity for members to make and renew acquaintances. Following this reception a trip has been arranged to the Griffith Park Planetarium, the only one west of the Mississippi. A lecture will be presented by the planetarium astronomer on the subject "Comets and Meteors," which should be most entertaining and instructive.

On Wednesday evening a dinner will be held in the nationally famous Cocoanut Grove, special arrangements having been made for the convention attendance. A section of the Grove will be reserved and those attending will be able to enjoy the regular floor show and dancing.

After the golf tournament on Thursday a "Noche de Fiesta" will be celebrated at the Riviera Country Club. At this informal gathering, a buffet dinner will be served, followed by presentation of sports prizes and dancing.

WOMEN'S ENTERTAINMENT

In addition to the entertainment already mentioned, special events have been arranged for women attending the convention: On Tuesday morning a window-shopping tour of Hollywood and Los Angeles stores may be taken, and in the afternoon a contest will be held on the Ambassador Hotel pitch and putt course. On Wednesday morning a trip is planned through Hollywood, Westwood, and Beverly Hills, where many of the homes of motion-picture celebrities can be seen. This trip will continue to the beaches with lunch arranged en route. On Thursday women guests will be taken to the Riviera Country Club and Deauville Club where swimming, golf, and putting are available. A dessert-bridge has also been arranged, starting at 1:00 p.m.

A reception committee will be at the registration desk to assist women guests to plan their time during the convention. Every assistance will be given to insure that they enjoy themselves in the way they most desire.

SPORTS

Thursday afternoon has been set aside for the annual golf tournament which will be held at the Riviera Country Club. This course is noted for its excellence, beauty, and its magnificent location in the Santa Monica hills close to the ocean. Those not wishing to play golf may spend the afternoon watching a polo game or at the near-by Deauville Beach Club, the full facilities of which will be available to members.

The main golf event will be the 18-hole handicap play for the John B. Fisken cup; this is limited to AIEE members. Additional prizes, available to both members and nonmember guests, will be given for events such as "Blind Bogey," "Lucky 3 Handicap," etc. The committee urges all members and guests, whether skilled in the ancient game or not, to plan on this afternoon of golf.

During the convention tennis matches will be arranged on the courts of the Ambassador Hotel. Other facilities of the hotel, such as the swimming pool and the pitch and putt course, will be regularly available.

INSPECTION TRIPS

Southern California points of interest selected for inspection trips include the Columbia Steel Plant at Torrance, KNX broadcasting transmitter, ship-to-shore radio station of the Southern California Telephone Company, new receiving station *E* of the Bureau of Power and Light, and the laboratories of the California Institute of Technology. If conditions permit, a visit to an aircraft factory may be included, although this of course will depend on national defense requirements at the time. Arrangements have been made for those who desire to see the 200-inch telescope at Mount Palomar to obtain admission. The 200-inch mirror, now undergoing final polishing at the California Institute of Technology in Pasadena, may also be seen. Trips will also be available to the Huntington Library and Art Gallery and to see the famous stained-glass window of the "Last Supper" at Forest Lawn, as well as to Chinatown and the Olvera Street Mexican Village. Additional trips to other local points of interest will be arranged on request.

Hotels and Rates

Hotel	Address	City Blocks From Headquarters	Single Room With Bath	Double Room With Bath
Ambassador	Wilshire Boulevard	Headquarters	$6.00	$6.50–8.00
Chapman Park	615 South Alexandria Avenue	One	$3.50	$5.00
Chancellor	3191 West Seventh Street	One	$2.50–3.50	$3.50–5.00
Gaylord	3355 Wilshire Boulevard	One	$4.00	$6.00 up
Langham	715 West Normandie Avenue	One-half	$3.00	$5.00–7.00
Mayan	3049 West Eighth Street	Three	$2.50	$5.00–9.00

REGISTRATION AND HOTELS

Members who plan to be in Los Angeles prior to the opening of the convention should indicate the fact when returning their advance registration cards, since the reception and trips committees will welcome the opportunity of meeting with them and furnishing suggestions for trips and entertainment. Registration may be completed upon arrival at the Ambassador Hotel headquarters on Monday evening, August 26, and should be definitely completed before 10:00 a.m. on Tuesday. A registration fee of $2.00 will be charged to nonmembers; no registration fee will be charged for Enrolled Students of the AIEE or the immediate families of members.

The past two conventions in the Los Angeles area have been outside the city limits. This time the Pacific Coast convention is to be at the Ambassador Hotel, which offers excellent convention facilities in a 22-acre playground within the city.

Detailed rates at the Ambassador Hotel are:

$4.00 per day per person, two in a room with bath and individual beds

$6.00 per day one person, in a room with bath

$3.50 per day per person, with four in two connecting rooms with bath and individual beds

$3.25 per day per person, with three in a room with bath and individual beds

Rates of hotels in the vicinity of the Ambassador are given in the accompanying tabulation. Members should make their hotel reservations by writing directly to the hotel of their preference.

COMMITTEES

The personnel of the 1940 Pacific Coast convention committee is as follows:

N. B. Hinson, *chairman;* M. A. Sawyer, *assistant to the chairman;* H. L. Caldwell, *vice-chairman;* J. M. Gaylord, *secretary;* F. C. Lindvall, *treasurer. Sub-committee chairmen:* J. H. Vivian, *technical program;* J. O. Binney, *registration;* W. W. LaBarr, *finance;* T. M. Blakeslee, *hotel;* H. S. Warren, *entertainment;* Mrs. R. W. Sorensen, *women;* E. L. Bettannier, *transportation;* O. W. Holden, *inspection trips;* O. A. Gustafson, *sports;* F. W. Maxstadt, *students;* A. P. Hill, *publicity. Members-at-large:* C. A. Andrews, J. W. Barker, C. F. Bowman, Neal Eaden, E. F. Evenson, L. R. Gamble, Fred Garrison, David Hall, R. H. Halpenny, G. K. Haspel, C. J. Hawkes, H. W. Hitchcock, J. P. Jollyman, J. E. McDonald, Corbett McLean, E. R. Northmore, E. F. Scattergood, R. W. Sorensen, and F. E. Young, Jr.

National • • • •

New Officers Elected at Summer Convention

At the annual meeting of the AIEE, held during the summer convention just concluded, the committee of tellers presented its report on the election of officers for the year beginning August 1, 1940. The new officers are:

President: R. W. Sorensen, professor and head of the department of electrical engineering, California Institute of Technology, Pasadena.

Vice-Presidents: E. S. Lee, engineer in charge of general engineering laboratory, General Electric Company, Schenectady, N. Y. (District 1, North Eastern); J. W. Barker, dean of engineering, Columbia University, New York, N. Y. (District 3, New York City); K. L. Hansen, consulting engineer, Harnischfeger Corporation, Milwaukee, Wis. (District 5, Great Lakes); J. L. Hamilton, assistant vice-president, Century Electric Company, St. Louis, Mo. (District 7, South West); A. L. Taylor, dean of the school of mines and engineering and head of the electrical-engineering department, University of Utah, Salt Lake City (District 9, North West).

Directors: T. F. Barton, assistant manager of the New York district, General Electric Company, New York, N. Y.; M. S. Coover, professor and head of the department of electrical engineering, Iowa State College, Ames; R. G. Warner, engineer, United Illuminating Company, New Haven, Conn.

National Treasurer: W. I. Slichter, professor and head of the department of electrical engineering, Columbia University, New York, N. Y. (re-elected).

The board of directors for the administrative year beginning August 1, 1940, will consist of these newly elected officers and the following holdover officers:

F. M. Farmer, New York, N. Y. (*retiring president*); John C. Parker, New York, N. Y. (*junior past president*); C. T. Sinclair, Pittsburgh, Pa.; F. W. Maxwell, Jr., University, Ala.; A. L. Turner, Omaha, Nebr.; H. W. Hitchcock, Los Angeles, Calif.; J. M. Thomson, Toronto, Ont. (*vice-president*); C. R. Beardsley, New York, N. Y.; Vannevar Bush, Washington, D. C.; F. H. Lane, Chicago, Ill.; L. R. Mapes, Chicago, Ill.; H. S. Osborne, New York, N. Y.; D. C. Prince, Philadelphia, Pa.; Mark Eldredge, Memphis, Tenn.; R. E. Hellmund, East Pittsburgh, Pa.; F. J. Meyer, Oklahoma City, Okla. (*directors*).

A detailed report of the AIEE summer convention will appear in the August issue.

Institute Co-operates in Census of Engineers for National Defense

The AIEE, through its Sections, is engaged in compiling a list of firms and individual electrical engineers in private practice in the United States, as its contribution to the nation-wide census of engineers and architects being prepared by national professional organizations in the program to coordinate civilian resources for national defense. Section committees will use available sources of information to list firms and individuals in the Section territory, indicating their specialties.

Also co-operating in the national census are the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Institute of Chemical Engineers, American Institute of Consulting Engineers, American Society of Heating and Ventilating Engineers, American Society of Military Engineers, American Society of Refrigerating Engineers, National Society of Professional Engineers, American Institute of Architects.

The census will have three parts: first, the listing of engineering and architectural firms and individuals in private practice, now in progress; second, classification of firms and individuals according to qualifications; and third, listing and classification of engineers, architects, draftsmen, surveyors, and specialists, who may be available to work with firms on assigned jobs.

Report of the Board of Directors

THE board of directors of the American Institute of Electrical Engineers presents herewith to the membership its 56th annual report, for the fiscal year ending April 30, 1940. A general balance sheet showing the condition of the Institute's finances on April 30, 1940, together with other detailed financial statements, is included herein. This report contains a brief summary of the principal activities of the Institute during the year, more detailed information having been published from month to month in ELECTRICAL ENGINEERING.

BOARD OF DIRECTORS' MEETINGS

During the year, the board of directors held five meetings, four in New York City, and one in San Francisco, Calif. The executive committee meetings in December and March were held in place of meetings of the board. Information regarding many of the more important activities of the Institute which have been under consideration by the board of directors and the committees is published each month in the section of ELECTRICAL ENGINEERING devoted to "Institute Activities".

PRESIDENT'S AND NATIONAL SECRETARY'S VISITS

President Farmer and National Secretary Henline attended the combined summer and Pacific Coast convention, the winter convention, the Great Lakes District meeting in Minneapolis, Minn., and the Middle Eastern District meeting in Scranton, Pa. They also visited many Sections and Student Branches. During May, President Farmer will visit the following Sections: Cincinnati, Cleveland, Erie, Worcester, Niagara Frontier, and Rochester; also he will attend a conference on student activities of the North Eastern District at Troy, N. Y. Both President Farmer and National Secretary Henline will attend the summer convention in Swampscott, Mass.

The places visited by President Farmer follow:

Alabama
- Alabama Section, Birmingham
- University of Alabama Branch, University

California
- Summer and Pacific Coast convention, San Francisco

Connecticut
- Connecticut Section, New Haven

District of Columbia
- Washington Section
- American Engineering Council, Washington

Georgia
- Georgia Section, Atlanta
- Georgia School of Technology Branch, Atlanta

Illinois
- Chicago Section, executive committee
- Midwest Power Conference, Chicago

Louisiana
- New Orleans Section
- Tulane University Branch, New Orleans
- Louisiana State University Branch, Baton Rouge

Michigan
- Michigan Section, Ann Arbor

Minnesota
- Great Lakes District meeting, Minneapolis
- Conference on student activities, Great Lakes District, No. 5, Minneapolis

Mississippi
- Conference on student activities, Southern District, No. 4, State College, Miss.

New York
- New York Section
- Winter convention
- Ithaca Section
- Cornell University Branch, Ithaca
- Schenectady Section
- Syracuse Section
- Syracuse University Branch

North Carolina
- North Carolina Section, Durham

Pennsylvania
- Middle Eastern District meeting, Scranton
- Conference on student activities, Middle Eastern District, No. 2, Scranton
- Pittsburgh Section
- Philadelphia Section

Canada
- Toronto Section

The places visited by the national secretary are the following:

California
- Summer and Pacific Coast convention, San Francisco
- Conference on student activities, Pacific District, No. 8, and North West District, No. 9, San Francisco

District of Columbia
- Washington Section
- American Engineering Council, Washington

Idaho
- University of Idaho Branch, Moscow

Illinois
- Armour Institute of Technology Branch, Chicago
- Urbana Section

Indiana
- Central Indiana Section, Indianapolis
- Fort Wayne Section

Massachusetts
- Lynn Section
- Worcester Section
- North Eastern District meeting, Springfield
- Conference on student activities, North Eastern District, No. 1, Springfield

Minnesota
- Great Lakes District meeting, Minneapolis
- Conference on student activities, Great Lakes District, No. 5, Minneapolis

Montana
- Montana Section, Butte

New York
- New York Section
- Schenectady Section
- Winter convention

Ohio
- Akron Section
- Columbus Section

Pennsylvania
- Sharon Section
- Philadelphia Section
- Middle Eastern District meeting, Scranton
- Conference on student activities, Middle Eastern District, No. 2, Scranton

Rhode Island
- Providence Section

Washington
- State College of Washington Branch, Pullman
- Seattle Section
- Spokane Section

Wisconsin
- Madison Section
- Milwaukee Section

Canada
- Vancouver Section

NATIONAL CONVENTIONS

Two national conventions were held during the year, and a brief report on each follows:

Summer and Pacific Coast Convention. The 55th summer convention combined with the 27th Pacific Coast convention was held in San Francisco, California, June 26–30, 1939. In addition to the annual business meeting, and conference of officers, delegates, and members, there were nine technical sessions at which 41 papers were presented, one general session, and two informal technical conferences. Doctor Adam S. Bennion, assistant to the president of the Utah Power and Light Company, gave an address on "Human Relationships" at the general session. In addition, there were two student technical sessions with presentation of 11 papers, and a Student Branch dinner with informal addresses by President John C. Parker, Vice-President H. W. Hitchcock, and Doctor R. W. Sorensen, chairman of the committee on student branches.

Entertainment and sports features of the convention were a tea, "AIEE Day" at the Golden Gate International Exposition on Treasure Island, banquet, and golf and tennis tournaments held in competition for the Mershon, Lee, and John B. Fisken trophies. The attendance was 940.

Annual Meeting. The annual business meeting of the Institute was held on Monday morning, June 26. The annual report of the board of directors for the fiscal year which ended April 30, 1939, was presented in abstract by the national secretary. A report on the finances of the Institute was presented by National Treasurer W. I. Slichter. The report of the committee of tellers upon the election of officers for the year beginning August 1, 1939, was presented, and President-Elect Farmer responded to his introduction with a brief address. During this session, the Lamme Medal for 1938, which was awarded to Marion A. Savage, was presented, being received by P. L. Alger who represented the medalist.

Winter Convention. The 28th winter convention was held in New York City, January 22–26, 1940, with a program including 85 papers presented in 18 technical sessions and 8 technical conferences. A brief general session was held at which the Alfred Noble prize was presented to C. E. Shannon (A'39).

At an evening session, the Edison Medal was presented to Philip Torchio, and the Hoover Medal was presented to Doctor Gano Dunn.

A smoker, numerous inspection trips, and ladies' events completed the program of the convention. The registration was 1,626, which was slightly above the 1939 figure, and the highest since 1924.

DISTRICT MEETINGS

Brief reports on the three District meetings held during the year are given below:

North Eastern District Meeting. This meeting and student Branch convention was held in Springfield, Mass., May 3–5, 1939.

Table I. Section and Branch Statistics

	For Fiscal Year Ending				
	April 30, 1936	April 30, 1937	April 30, 1938	April 30, 1939	April 30, 1940
Sections					
Number of Sections	61	62	65	67	70
Number of meetings held	540	621	624	635	701
Total attendance	85,501	74,950	110,148	85,692	91,949
Branches					
Number of Branches	118	119	120	120	121
Number of meetings held	1,045	1,363	1,334	1,190	1,346
Total attendance	45,304	46,121	60,446	53,380	64,972

There were four technical sessions, two student sessions, and a general session with addresses by President John C. Parker and President C. W. Kellogg of the Edison Electric Institute, the latter on the subject "The Engineer as a Citizen". The Faraday Medal of The Institution of Electrical Engineers, Great Britain, was presented to Doctor W. D. Coolidge, director of the General Electric Company Research Laboratory, Schenectady, N. Y., by Dr. Gano Dunn, local honorary secretary of the IEE for the United States. Inspection trips, stag smoker, ladies' entertainment, and banquet completed the meeting. The attendance was 439.

Great Lakes District Meeting. This meeting was held in Minneapolis, Minn., September 27–29, with four technical sessions, at which 18 papers were presented, and one student session. The entertainment program consisted of a dinner and dance with a demonstration by Doctor Phillips Thomas, research engineer of the Westinghouse Electric and Manufacturing Company. Also Doctor W. A. O'Brien, pathologist of the University of Minnesota, addressed an audience at a noon luncheon. Inspection trips, ladies' events, a District conference on student activities, and a District executive committee meeting were included in the program. The registration was 230.

Middle Eastern District Meeting. The tenth meeting of this District was held in Scranton, Pa., October 11–13, 1939, with 5 sessions at which 21 technical papers were presented. A District conference on student activities, a District executive committee meeting, ladies' events, inspection trips, stag smoker, and informal dinner, at which President R. E. Desvernine of the Crucible Steel Company of America gave an address on "Business and World Politics", completed the program. The attendance was 313.

SECTIONS

The three new Sections organized, Charleston, El Paso, and South Carolina, brought the total number to 70. The name of the Dallas Section was changed to "North Texas", and its territory was extended to the north and northwest. On account of the fact that its territory includes the major part of the state of Maryland, the name of the Baltimore Section was changed to "Maryland". Nine unassigned counties in Maine were assigned to the Lynn Section, which now has the entire state. Organization of new Sections and extensions of the territories of others have reduced to about 100 the number of members in the United States outside Section territories.

Activity was reported by all Sections. The total number of meetings reported was 701 as compared with 635 for the preceding year, and this was the sixth consecutive year in which the number exceeded that for the preceding year.

Fifteen Sections reported that their 30 technical groups or other subdivisions had held 124 meetings of these types in addition to the 131 regular Section meetings.

In October, the Sections committee issued a printed pamphlet "Section Activities", which is expected to be of material assistance to Section officers by indicating the types of activities which have been found to be most effective. A second edition of the pamphlet "The Electrical Engineer", for the guidance of high school students interested in electrical engineering, was prepared under the joint direction of the Sections committee and the committee on Student Branches.

The Sections committee sent a communication to all Sections, in October, recommending the appointment by each of committees on (*a*) legislation, (*b*) economic and social affairs, and (*c*) vocational guidance.

Many Sections have shown increased interest in the stimulation of younger members to participate in the activities more freely. The continuing interest in and success of the technical group discussion plan, the inclusion of younger members among Section officers and committees, and the appointment of committees to develop activities for the younger engineers are a few of the tangible evidences of progress in this direction.

The Sections committee has been developing a comprehensive plan for the preparation of news items on outstanding Section activities for publication in ELECTRICAL ENGINEERING, and many such items have appeared in recent months. Through the use of extensive questionnaires the committee is making a thorough study of all phases of Section activities.

More detailed information on these activities may be found in the annual report on Section and Branch activities in the June issue of ELECTRICAL ENGINEERING, pages 250–3.

STUDENT ACTIVITIES

A new Branch organized at the University of Alberta brought the total number to 121.

The total number of meetings reported was 1,346, as compared with 1,190 for the preceding year, 1,334 for 1937–38, and 1,363 for 1936–37. Only two Branches failed to report any activity, 21 held more than 15 meetings each, 24 held from 12 to 15, 40 held from 8 to 11, 26 held from 4 to 7, and 8 held from 1 to 3 meetings.

Although the total number of student talks at Branch meetings was higher than for the preceding year, 767 as compared with 725, it was far below the numbers for some previous years. The largest number reported for any year was 1,130 for 1936–37.

The numbers of student sessions and papers at the summer-Pacific Coast convention and three District meetings are given in the reports on those meetings. The students have continued to show keen interest in such participation, and the quality of student papers and their presentation has been high.

With the co-operation of the committee on Student Branches, the committee on safety again suggested that each Branch have presented a paper on prevention of accidents or remedial measures after electric shock. A large number followed the suggestion.

A meeting of the committee on Student Branches was held during the 1940 winter convention, with 50 members and invited guests present. A report on the meeting appeared on pages 124–5 of the March issue of ELECTRICAL ENGINEERING.

The committee on Student Branches and the Sections committee co-operated in the preparation of a second edition of the pamphlet "The Electrical Engineer" for the guidance of high school students interested in electrical engineering. Distribution of copies was begun in March.

The committee on Student Branches urged the Branches to celebrate the 75th birthday of Doctor Charles F. Scott, originator of the plan for organizing Branches. The Scott motion-picture films were shown by about 75 Branches, in many cases at joint meetings with neighboring Sections or Branches.

Of the 1,624 enrolled students whose terms were expected to expire on April 30, 911 (56 per cent) applied for admission as Associates. Some are eligible to continue as enrolled students on account of remaining in school.

A more detailed summary of student activities may be found in the annual report on Section and Branch activities in the June issue of ELECTRICAL ENGINEERING, pages 250–3.

TECHNICAL PROGRAM COMMITTEE

The technical papers on convention programs have been of a high quality, with many favorable comments received. Pursuing the policy of the previous year, the technical program for the 1940 winter convention was enlarged to 18 technical sessions and 8 technical conferences, one more technical session and three more conferences than were held in the previous year. The enlarged program met with an excellent response from the membership, as evidenced by the registered attendance, 1,626, which was slightly more than the attendance of the previous year, and the largest attendance since 1924. The committee also arranged the technical program for the 1939 summer and Pacific Coast convention, and papers were supplied for the District meetings in Springfield, Mass.; Minneapolis, Minn.; and Scranton, Pa. A total of 177 papers were presented at these two national conventions and three District meetings, of which 151 were recommended for TRANSACTIONS publication.

Table II presents statistics for the pro-

Table II. Technical Programs, Last Two Years

	Year Ending April 30, 1940	Year Ending April 30, 1939
Number of national conventions	2	3
Number of District meetings	3	3
Registration at national conventions and District meetings	3,548	4,100
Number of papers presented	177	184
Number of papers recommended for TRANSACTIONS	151	169
Estimated number of pages required for printing papers in TRANSACTIONS	886*	986*
Average length of papers recommended for TRANSACTIONS	5.86	5.83
Number of technical sessions	43	50
Number of technical conferences	10	12

* Partly estimated.

grams of the past two years. These statistics are not directly comparable, as there was one less national convention during the past year due to the fact that the summer and Pacific Coast conventions were combined.

Oral Presentations. With a view toward improving the effectiveness of the oral presentations, each speaker and presiding officer at the last winter convention has been canvassed. Many helpful suggestions from a broad section of actual experience have been received. These suggestions will be carefully analyzed, mimeographed, and sent to speakers on future programs. In this way it is hoped to bring about improvement in some of the oral presentations to the mutual advantage of both the speakers and the audience.

Technical-Committee Reports. The preparation of technical-committee reports on the progress of the art has been stimulated. A report on progress of the art in electrical machinery was presented at the summer convention. Reports on progress in the production and application of light and progress in power generation, 1933–39, were presented at the winter convention. Reports by the committees on communication, protective devices, electronics, and instruments and measurements are in preparation. As most of the technical committees have not had reports since 1934, and it is planned to include developments during the intervening years, the reports will be more comprehensive than heretofore. As an experiment and for the purpose of making the reports more readable and presentable, some of the reports will be prepared by an experienced writer. Through this service, technical committee reports will receive more extensive publicity in circles outside of Institute activities.

New Trends in Policy. While the average length of papers for the fiscal year has remained practically the same as for the preceding year, 5.86 pages per paper as compared with 5.83, nevertheless the papers for the past winter convention as compared with the winter convention of the previous year were reduced from 6.50 pages per paper to 5.60. Technical committees have been requested to continue their efforts for shorter papers, which will permit the scheduling of more papers within the annual budget. Notwithstanding this reduction, when the winter convention program was determined, there still remained 51 papers on the docket which had to be held over for future meetings.

As a result of the foregoing situation, a subcommittee was appointed. It was believed that some of the more highly specialized papers of limited interest could be presented in technical conferences without TRANSACTIONS publication, and that more material could be presented in this way. The duties of the subcommittee were to study the whole problem, and a report entitled "Suggested Modifications in Methods of Handling AIEE Technical Papers and Conferences" has been made. This report was discussed at the March 15 meeting of the technical program committee, and referred back to the subcommittee for revision in the light of the discussion at that meeting.

The revised report of the subcommittee, if accepted, will divert some of the more highly specialized papers of interest to only a few and other papers which are only of transitory interest from the TRANSACTIONS to a less expensive form of publication. These papers would be permanently recorded by the publication of synopses. Preprints would be made available and the original copy filed in the Engineering Societies Library. Other unapproved conference papers would also be preserved by filing in the Library at the option of the author. The report also recommends the publication of a synopsis of every formal paper in ELECTRICAL ENGINEERING as soon as the paper has been approved for preprinting. It also recommends that some papers with longer mathematical calculations should have the appendices made available in preprint form only.

Acknowledgments. The committee is grateful for the active participation and co-operation in the work by its members, the chairmen of the technical committees, the reviewers of papers, and the members of the Institute's staff.

PUBLICATION COMMITTEE

With the transition period involved in the adoption of the present publication policy largely behind, constant attention has been given to observing residual defects and devising minor modifications to overcome them. While the general reaction of the membership continues to be very favorable, some adverse criticisms have been received and these have had and are having careful consideration.

The booklet "Preparation of Manuscripts" has been completely revised and enlarged, and is now available under the title "Information for Authors". A lack of familiarity of some authors and members with the provisions of the present publication policy has caused confusion in some cases. The new booklet "Information for Authors" contains for the first time a full statement of publication policy, and it is hoped that members and authors will take advantage of this opportunity to become thoroughly familiar with the publication policy.

During the year, a critical study has been made of AIEE publication costs, and this study included a comparison with the publication costs and procedures of three other national technical organizations. The analysis shows that in relation to the total cost to them, our members receive publication service which compares very favorably with that provided by the other organizations. The economy and efficiency of our publication procedures is indicated by the fact that last year the net publication expense per member in our Institute was only one-half of the corresponding figure in another organization having nearly the same membership.

The operating statement for the first half of the appropriation year (October 1st, 1939, to March 31st, 1940) shows that the publication committee has operated within its budget for that period.

Recently Donald M. Simmons, who has rendered valuable service on the publication committee for several years, was appointed vice-chairman of the committee.

The publication committee continues to welcome comment and criticism from all Institute members.

MEMBERSHIP COMMITTEE

The membership committee has endeavored to improve its effectiveness this year by laying increased stress on better organization of its various groups, thereby obtaining better co-ordination of effort and less duplication of work among the many members assigned to this activity. The national committee duties were outlined in

Table III. Membership Statistics for the Fiscal Year Ending April 30, 1940

	Honorary	Fellow	Member	Six-Year Associate	Associate	Total
Membership on April 30, 1939	9	722	4,392	5,726	5,756	16,605
Additions						
Transferred		58	171	515		
New members qualified			127	25	1,472	
Former members reinstated		1	3	16	12	
	9	781	4,693	6,282	7,240	
Deductions						
Died	1	10	47	37	8	
Resigned			39	140	126	
Transferred			58	151	535	
Dropped		4	54	230	352	
	1	14	198	558	1,021	
Membership on April 30, 1940	8	767	4,495	5,724	6,219	17,213

Table IV. Number of Applications Received From Enrolled Students and From All Others

Year Ending	From Students	From All Others	Total
April 30, 1940	911	918	1,829
April 30, 1939	849	872	1,721
April 30, 1938	739	932	1,671
April 30, 1937	716	1,040	1,756
April 30, 1936	631	946	1,577

Table V. Number of Enrolled Students

April 30, 1940	5,517	(2,991)
April 30, 1939	5,242	(2,271)
April 30, 1938	5,037	(2,428)
April 30, 1937	4,503	(2,249)
April 30, 1936	4,049	(1,991)

Following the number of students reported for April 30 of each year is indicated within parentheses the number of new applications received during that year; the difference between this number and the reported total, of course, reflects the number of renewals of Student enrollment for the corresponding period.

Table VI. Number of Members in Section Territory Reinstated

August 1, 1939 to April 30, 1940	249
Year Beginning August 1, 1938	354
Year Beginning August 1, 1937	325
Year Beginning August 1, 1936	503
Year Beginning August 1, 1935	663

a communication from the chairman at the start of the committee year.

The Section membership committees were supplied copies of specially prepared instructions and guides to assist their early organization into efficient working groups. A census of Section membership committee personnels was requested early in the year to stimulate early organization in the Sections and to permit the Institute to give these men recognition for the effort they put forth each year. Accordingly, the complete Section membership committee lists were published in the January 1940 issue of ELECTRICAL ENGINEERING. The membership committee is grateful to the publication committee for its full co-operation in this effort.

As of January 1940, there were 494 men assigned to Section membership committees with an unknown additional number working on Section subcommittees.

In the national committee ten vice-chairmen continued as the membership "chiefs" of their respective Districts, and a small group of five members-at-large was set up for advice and assistance to the chairman. The committee held two meetings during the year at headquarters.

The committee has gone further in the direction of personalizing membership work both to bring the Institute closer to its Section committees and to bring the entire membership closer to the Institute. The Sections have been asked to give personal recognition to each new member at his first meeting and to give recognition to the proper membership committeeman responsible for obtaining the new addition to the Section at the same meeting.

The chairman has written personally, so far as was possible, to each member who desired information concerning membership matters, and has received many letters indicating favorable reaction to this policy.

Table VIII. Memberships Fully Paid

Year	Membership as of April 30	Number of Members Fully Paid as of April 30	Per Cent Fully Paid
1940	17,213	14,997	87.1
1939	16,605	14,371	86.5
1938	16,078	14,127	87.9
1937	15,308	13,439	87.8
1936	14,600	12,446	85.2
1927*	18,344	16,247	88.6

* Year of maximum membership.

Table IX. Record of AIEE Membership

Total Membership May 1		Total Membership May 1		Total Membership May 1	
1884	71	1904	3,027	1923	15,298
1885	209	1905	3,460	1924	16,455
1886	250	1906	3,870	1925	17,319
1887	314	1907	4,521	1926	18,158
1889	333	1908	5,674	1927	18,344
1890	427	1909	6,400	1928	18,265
1891	541	1910	6,681	1929	18,133
1892	615	1911	7,117	1930	18,003
1893	673	1912	7,459	1931	18,334
1894	800	1913	7,654	1932	17,550
1895	944	1914	7,876	1933	17,019
1896	1,035	1915	8,054	1934	15,230
1897	1,073	1916	8,202	1935	14,269
1898	1,098	1917	8,710	1936	14,600
1899	1,133	1918	9,282	1937	15,308
1900	1,183	1919	10,352	1938	16,078
1901	1,260	1920	11,345	1939	16,605
1902	1,549	1921	13,215	1940	17,213
1903	2,229	1922	14,263		

The assistance of the student counselors was solicited in January and February in an effort to encourage a maximum number of eligible Enrolled Students to apply for Associate grade. The counselors' help was very valuable, and the committee extends its appreciation to them.

It is the feeling of the committee that the improvements attained in organization were effective and well worth the effort. Evidence of this may be seen in tables III and IV, where it is shown that the total membership has increased from 16,605 to 17,213, and that 1,829 applications were received during the year ending April 30, 1940. The number of applications shows an increase of over 6 per cent above the same figure last year.

Table VII. Membership of the Institute, April 30, 1940

Of the 17,213 members reported for April 30, 1940, 14,997 are fully paid to April 30, 1940. The balance of 2,216 are divided into the following groups:

1. Members owing dues to April 30, 1939 Total number of members who have not acted upon resolution of board of directors adopted in January 1940 providing an extension of time for payment of dues	634
2. Members owing dues to April 30, 1940	1,582

(During the period May 1 to 15, 1940, 326 members have paid dues to April 30, 1940, reducing the total to 1,256.)

Table V shows another increase in the number of Enrolled Students. This is important since about half of the applications for membership come from the Students, as will be seen in table IV.

Table VI shows a continuing decrease in the number of delinquents reinstated, as may be expected unless business conditions become more adverse over a considerable period of time. This is due to the number of probable prospects being continually reduced.

Table VII shows about the same conditions as last year, though table VIII indicates a small improvement in the percentage of the members with dues fully paid.

DEATHS

The deaths of 103 members reported during the year are listed in table X.

BOARD OF EXAMINERS

The board of examiners held 11 meetings during the past year, averaging about two and one-half hours each, and considered 4,250 cases, divided as shown in table XI.

The Procedure of the Board. It has become increasingly apparent to the board of examiners that the membership of the Institute needs to know more of the requirements in the constitution and bylaws with regard to membership grades as well as the technique of the board in handling applications for admission and transfer. Evidence of this is found in requests for procedure whereby the board could give advance indications of likely action in cases in which certain Sections are particularly anxious to avoid embarrassment to the applicants and to the membership and transfer committees. Realizing that every effort should be made to make the problems and procedures of the board of examiners better understood by the membership, it was voted that the following statement should be incorporated in this year's annual report to the board of directors.

A study of the "advance or informal opinion" suggestion makes it evident that the motivating factor is doubt as to eligibility, usually with regard to transfer to the grade of "Fellow", of men of local prominence. An attempt to provide for this situation is evidenced by the adoption in 1923 of the revision of the bylaws legalizing a "transfer proposal" form, which now, however, applies only to Member grade. The practical application of that proposal form immediately resulted in serious trouble. Due to local pressure, the signatures of endorsers were obtained on the proposal form, yet on the confidential reference blanks sent out by headquarters, as required by the constitution, the former endorsers in certain instances failed to recommend transfer. Again, the abbreviated records supplied on the proposal forms were not sufficient in many cases to permit the examiners to form even informal opinions on eligibility. Finally, men were proposed for advancement who had no desire to transfer, and when word reached them of the action taken they expressed their objections to the procedure in no uncertain terms. In one notable case, where the examiners on consideration of the complete formal application felt compelled to reverse their informal decision based on a "proposal" record, a Section secession threat resulted. The board of examiners has therefore not encouraged the "advance opinion or proposal form" as an ineffective mechanism for obtaining the advance of applicants to appropriate and constitutionally authorized grades of membership.

The suggestion that unfavorable action be postponed until some local group has been contacted has also been studied on many occasions by many boards. As a matter of fact, the suggested procedure has been practiced as far as practical by the examiners for many years, within the limits of the constitution and bylaws. A considerable part of the correspondence of the secretary of the board of examiners is concerned with building up of complete professional records of applicants and obtaining the required number and grade of references. This correspondence is with local Section officers where the situation warrants such action, otherwise it is with the applicants or their references. The examiners believe, however, that to restrict the board in its present freedom to accommodate the method of inquiry to the circumstances in each case would lead to added difficulties, particularly in transfer cases. On all direct admission applications, the character question is involved; they are therefore posted and are the subject of general knowledge in advance of examiners action. On the contrary, transfer applications are frequently transactions solely between the applicants and the Institute; they are not published in any way and are otherwise known only to the supporting references. To divulge likelihood of unfavorable action to local officers or committees would be seriously objected to by many as a violation of a confidential privilege accorded to members. It might easily defeat the desired objective of encouraging meritorious transfers.

The suggestion has been made that the board of examiners be instructed to report tentative decisions to the local Sections in advance of final action on cases of direct admission or transfer to higher grades. The board feels, however, that stipulation of such procedure would tend to limit freedom of final action in accordance with the requirements of the constitution and bylaws and thus seriously curtail the independence and hamper the effectiveness of the board in its function of maintaining a high standard of Institute membership in the upper grades. It should be pointed out here that most of the members of the board of examiners have been active in Sections, local and national membership committees, over a long period of years and have had full experience in the problems now before us. To this they have added the experience on the board of examiners in dealing with many difficult cases. The board, after giving careful consideration to these important problems, therefore, does not look with favor upon the prescription of a procedure which would require a divulgement of probable action based on incomplete information about the applicant. Sponsors of such applicants often have receded from an advocacy which was founded on an incom-

Table X. Deaths of AIEE Members Reported During the Fiscal Year

Name	Date of Election	Date of Death	Grade at Death	Obituary Notice in ELECTRICAL ENGINEERING
Allen, Edwin W.	Associate '03	Jan. 1, 1940	Fellow	Feb. 1940, p. 90
Allensworth, H. R.	Associate '04	Nov. 29, 1939	Member	Feb. 1940, p. 91
Arnold, H. S.	Associate '11	July 24, 1939	Associate	Jan. 1940, p. 49
Ashbrook, R. B.	Associate '20	Aug. 15, 1939	Member	Nov. 1939, p. 492
Bayha, L. H.	Associate '33	Sept. 17, 1939	Associate	Dec. 1939, p. 541
Belshe, R. L.	Associate '35	May 24, 1939	Associate	July 1939, p. 323
Beugler, H. M.	Associate '03	July 16, 1939	Member	Sept. 1939, p. 398
Bourath, J. N.	Associate '21	May 13, 1939	Associate	Aug. 1939, p. 363
Bryant, R. B.	Associate '09	May 21, 1939	Associate	Aug. 1939, p. 363
Burke, James	Associate '93	Jan. 21, 1940	Fellow	March 1940, p. 134
Carnahan, G. C.	Associate '20	April 15, 1939	Associate	Aug. 1939, p. 363
Cleaves, B. F.	Associate '23	July 30, 1939	Associate	Sept. 1939, p. 398
Clements, F. W.	Associate '08	Dec. 12, 1939	Associate	May 1940, p. 217
Cook, Leonard	Associate '39	March 29, 1940	Associate	May 1940, p. 217
Cornford, F. J.	Associate '23	Nov. 5, 1939	Associate	Jan. 1940, p. 50
Cox, F. P.	Associate '01	Nov. 30, 1939	Fellow	Jan. 1940, p. 50
Cramp, William	Member '26	April 20, 1939	Member	June 1939, p. 280
Crosby, G. L.	Associate '15	Dec. 2, 1939	Member	Jan. 1940, p. 50
Crozier, H. W.	Associate '03	April 13, 1939	Member	June 1939, p. 280
Davis, C. W.	Member '29	Sept. 16, 1939	Member	Nov. 1939, p. 492
Davis, G. S.	Associate '04	Dec. 29, 1939	Member	April 1940, p. 174
Denehy, H.	Associate '12	Feb. 21, 1940	Associate	May 1940, p. 217
de Sousa, A. M.	Associate '28	1939	Associate	Oct. 1939, p. 445
Dill, G. C.	Associate '13	April 1, 1939	Member	June 1940, p. 258
Dodge, O. G.	Associate '93	June, 1936	Member	Feb. 1940, p. 91
Doherty, H. L.	Associate '98	Dec. 27, 1939	Fellow	Feb. 1940, p. 90
Donnelly, A. L.	Associate '18	1939	Associate	Jan. 1940, p. 50
Doxey, F. S.	Associate '26	Jan. 12, 1940	Associate	March 1940, p. 135
Fields, W. S.	Associate '25	March 9, 1939	Associate	June 1939, p. 281
Finley, J. H.	Associate '27	March 10, 1939	Associate	July 1939, p. 323
Firman, L. D.	Associate '06	1939	Member	Nov. 1939, p. 492
Foster, S. C.	Associate '11	April 22, 1939	Associate	Aug. 1939, p. 363
Fung, J. T. S.	Associate '35	1939	Associate	Dec. 1939, p. 541
Garton, W. R.	Associate '05	Sept. 15, 1939	Associate	Dec. 1939, p. 540
Garvin, J. P.	Associate '23	May 12, 1939	Member	Sept. 1939, p. 398
Gibson, J. J.	Associate '02	May 6, 1939	Fellow	June 1939, p. 279
Graef, W. H.	Associate '08	Feb. 20, 1940	Member	May 1940, p. 217
Gravell, J. H.	Associate '17		Associate	Feb. 1940, p. 90
Gray, E. T.	Associate '23	July 6, 1939	Associate	Sept. 1939, p. 398
Hagenbuch, L. G.	Associate '34	Oct. 1, 1939	Associate	Dec. 1939, p. 541
Harrington, A. L.	Associate '07	Nov. 15, 1939	Associate	March 1940, p. 135
Hecker, A. E.	Member '30	June 1, 1939	Member	Jan. 1940, p. 50
Henry, I. W.	Member '36	April 25, 1940	Member	June 1940, p. 257
Hesketh, Thomas	Associate '04	March 1939	Member	June 1939, p. 280
Hirt, E. L.	Associate '18	May 28, 1939	Associate	July 1939, p. 322
Hogshead, C. C.	Associate '35	March 14, 1939	Associate	Jan. 1940, p. 50
Honegger, Arnold	Associate '15	June 20, 1939	Member	Nov. 1939, p. 492
Hopkins, I. B.	Associate '37	Jan. 12, 1940	Associate	April 1940, p. 174
Horan, Michael	Associate '29	Jan. 19, 1940	Associate	May 1940, p. 218
Hughes, C. P.	Member '39	July 7, 1939	Member	Sept. 1939, p. 399
Jacobi, W. O.	Associate '10	April 10, 1939	Member	Aug. 1939, p. 362
Johnston, D. H.	Member '28	Sept. 12, 1939	Member	Dec. 1939, p. 541
Kennelly, A. E.	Associate '88	June 18, 1939	Fellow	July 1939, p. 322
Knight, C. D.	Associate '05	Feb. 28, 1940	Member	April 1940, p. 173
Komaru, Toda	Associate '20	March 14, 1939	Associate	Aug. 1939, p. 363
Kramer, C. H.	Associate '20	Feb. 28, 1939	Member	July 1939, p. 323
Lagomasino, J.	Associate '38	1940	Associate	June 1940, p. 258
Little, A. P.	Associate '09	Dec. 28, 1939	Member	March 1940, p. 135
Little, C. W. G.	Associate '96	1939	Associate	Nov. 1939, p. 492
Livingston, J.	Associate '98	Oct. 10, 1939	Associate	Dec. 1939, p. 541
Marks, L. B.	Associate '90	Nov. 22, 1939	Fellow	Jan. 1940, p. 50
McRae, W. R.	Member '17	1939	Member	Dec. 1939, p. 540
Merizzi, G.	Associate '12	1939	Associate	Aug. 1939, p. 363
Messick, C.	Associate '03	May 25, 1939	Member	July 1939, p. 323
Mountain, J. T.	Associate '04	April 16, 1939	Fellow	July 1939, p. 323
Mowry, H. W.	Associate '18	Dec. 10, 1939	Member	Feb. 1940, p. 91
Nielsen, W. C.	Associate '37	Oct. 4, 1939	Associate	Feb. 1940, p. 91
Norris, H. H.	Associate '03	April 14, 1940	Fellow	May 1940, p. 217
Nunn, P. N.	Associate '95	Oct. 27, 1939	Member	Dec. 1939, p. 540
O'Brien, P. O.	Associate '24	March 10, 1940	Associate	May 1940, p. 217
Ost, P. J.	Member '23	Dec. 30, 1939	Member	March 1940, p. 135
Piek, Stefaan	Associate '06	Dec. 13, 1939	Associate	Feb. 1940, p. 90
Popkin, M. E.	Associate '19	Jan. 29, 1940	Associate	March 1940, p. 135
Pringle, D. R.	Associate '07	Aug. 4, 1939	Associate	Oct. 1939, p. 445
Ralston, E. G.	Associate '21	April 17, 1939	Member	June 1939, p. 280
Ramsay, J. W.	Associate '36	July 22, 1939	Member	Sept. 1939, p. 398
Renshaw, E. N.	Associate '18	May 16, 1939	Associate	July 1939, p. 323
Reynolds, W. H.	Associate '04	Jan. 12, 1940	Member	March 1940, p. 135
Robertson, W. L.	Associate '05	Nov. 17, 1939	Associate	Jan. 1940, p. 50
Roth, Edouard	Associate '18	April 29, 1939	Associate	June 1939, p. 280
Rugg, W. S.	Associate '02	April 25, 1940	Member	June 1940, p. 257
Sawyer, R. E.	Associate '30	Oct. 29, 1939	Associate	Jan. 1940, p. 50
Scoville, G. A.	Associate '05	Jan. 14, 1940	Member	March 1940, p. 135
Servos, F. M.	Associate '19	July 8, 1939	Member	Sept. 1939, p. 397
Sessions, A. P.	Member '37		Member	Feb. 1940, p. 91
Seyfert, S. S.	Associate '05	Dec. 11, 1939	Member	Jan. 1940, p. 49
Shannon, J. H.	Member '25	Jan. 16, 1940	Member	March 1940, p. 135
Silbert, R. H.	Associate '17	1939	Member	Nov. 1939, p. 493
Smith, G. H.	Associate '20	Sept. 10, 1939	Member	Oct. 1939, p. 445
Smith, J. C.	Associate '03	June 24, 1939	Fellow	Aug. 1939, p. 362
Spangenberg, O. C.	Associate '16	June 6, 1937	Associate	Sept. 1939, p. 398

(*Continued on next page*)

Table X (Continued). Deaths of AIEE Members Reported During the Fiscal Year

Name	Date of Election	Date of Death	Grade at Death	Obituary Notice in Elcctrical Engineering
Steele, G. F.	Associate '10	June 25, 1939	Member	Aug. 1939, p. 362
Stevens, W. C.	Associate '11	May 15, 1939	Fellow	July 1939, p. 322
Storms, C. A.	Associate '26	Aug. 21, 1939	Member	Oct. 1939, p. 445
Taggart, J. E.	Member '37		Member	April 1940, p. 173
Tibbetts, F. H.	Member '30	August, 1938	Member	July 1939, p. 322
Trudgian, Wm.	Associate '27	Sept. 19, 1939	Associate	Nov. 1939, p. 493
Vanderpoel, W. K.	Associate '08	Oct. 21, 1939	Member	Dec. 1939, p. 540
Wagner, G. J.	Member '20	Sept. 2, 1939	Member	Dec. 1939, p. 540
Waring, S. B.	Associate '35	1939	Associate	Nov. 1939, p. 493
Wilkinson, G. D.	Associate '25	July 5, 1939	Associate	Sept. 1939, p. 398
Wood, E. D.	Associate '21	Nov. 9, 1939	Member	Dec. 1939, p. 540
Woodcock, L. R.	Associate '09	July 1, 1939	Member	Sept. 1939, p. 397

plete record of professional attainment. On the contrary, the board believes the responsibilities and necessarily confidential procedures of the board would be better appreciated by the members if more emphasis were placed on the importance of filing complete professional records on the initial applications for direct admission or transfer to higher grades.

To correct any false impression as to the number of applications for admission and transfer on which the examiners have felt compelled to rule unfavorably, a summary for the last ten-year period, 1931–40, is presented in table XII.

It should be noted that the figures in table XII show a total rejection of Fellow grade applications over the ten-year period of only 29. The Member rejections (about 11 per cent) are apparently due in part to a failure to appreciate the technical experience required for that grade and the tendency of applicants to select Member grade merely because they have passed the 27-year lower-age limit. Comparison of conditions before and after the increase of Associate dues at the end of the six-year period seems to indicate that it has also been a potent factor in developing ineligible Member applications.

Table XI. Applications for Admission and Transfer

Applications for Admission		
Recommended for grade of Associate	1,724	
Re-elected to the grade of Associate	86	
Not recommended	4	1,814
Recommended for grade of Member	122	
Re-elected to the grade of Member	12	
Not recommended	44	178
Recommended for grade of Fellow	1	
Re-elected to the grade of Fellow	0	
Not recommended	0	1
Applications for Transfer		
Recommended for grade of Member	167	
Not recommended	24	191
Recommended for grade of Fellow	53	
Not recommended	3	56
Students		
Recommended for enrollment as Students		2,010
Total		4,250

Table XII. Rulings by Examiners 1931–40

	Recommended	Not Recommended
Admissions		
Associates	11,426	183
Members	1,078	284
Fellows	23	10
Transfers		
Members	1,781	184
Fellows	284	19

STANDARDS COMMITTEE

The four standards co-ordinating committees organized during the past year have devoted themselves to the tasks assigned to them.

Committee No. 1, Reference Values for Standards, has collected extensive data relating to existing practices on reference values. A paper covering this subject will be presented at the summer convention.

Committee No. 2, Standard Voltages and Currents, is keeping in close touch with the activities of the corresponding NEMA and EEI committees dealing with voltages above 100. Furthermore, a subcommittee has been organized to study the possibilities of standardization for voltages below 100. This subcommittee has collected considerable information on existing practices, and is ready to co-operate with the newly organized ASA sectional committee on the same subject.

Committee No. 3, Insulation Testing and Co-ordination, has appointed a group of AIEE representatives to work with the NEMA and EEI committees handling insulation co-ordination. In addition, a subcommittee on insulation testing and evaluation has been organized, which for the present is collecting data on existing practices in insulation testing and on methods for evaluating insulation. Another subcommittee on the standardization of wet tests has just been organized, and will attempt to unify greatly divergent standards provisions now existing.

Committee No. 4, Basic Principles for Rating of Electrical Machinery and Apparatus, sponsored several papers relating to its activity during the 1939 AIEE summer convention and at the District meeting in Scranton, Pa. The committee has had several meetings, and worked out a complete revision of standard No. 1, General Principles Upon Which Temperature Limits Are Based in the Rating of Electrical Machinery and Apparatus, which has been approved by the standards committee. The co-ordinating committee is now undertaking a study of short-time and intermittent ratings and loads, and a number of papers covering the subject will be presented at the summer convention.

In addition to these four committees, two new co-ordinating committees have been organized, namely: No. 5, Basic Theories and Units, and No. 6, Interference, Sound, and Noise Problems. Both committees are preparing to start actual work.

The first topic requiring the consideration of committee No. 5 will be the relative merits of the rationalized versus the unrationalized system of mks units, and the advisability of the endorsement of the preferred system by the Institute. The article "Revision of Electrical Units" by E. C. Crittenden in the April 1940 issue of Electrical Engineering bears on this topic.

The co-ordinating committees, in addition to carrying on their major activities, have been active in reviewing various standards submitted to the standards committee for approval, to assure the maximum uniformity and co-ordination of these standards with others in existence. Additional co-ordinating committees may be organized as the desirability or need for other activities becomes apparent.

A decided increase in the activities of various sectional committees of ASA concerned with problems in the electrical field was noted during the year, and this called for the appointment of individual Institute representatives as well as AIEE delegations. Among such activities may be mentioned the following: Vacuum Tubes for Industrial Purposes—*C*60; Wire and Sheet Metal Gages—*B*32; Storage Batteries—*C*40; Industrial Lighting—*A*11; Radio—*C*16; Dry Cells—*C*18; and Carbon and Graphite Brushes—*C*64.

The chief development in published standards and one of great interest to the Institute was the issuance by ASA of the Proposed Standard for Transformers. This publication, it is hoped, will shortly be approved as an American standard. It replaces AIEE standards Nos. 12, 13, 14, 100, and the Test Code for Transformers. In addition, three revisions of existing Institute standards were submitted and will be published, as follows: General Principles Upon Which Temperature Limits Are Based in Rating of Electrical Machinery; Measurement of Test Voltages in Dielectric Tests; Air Switches and Bus Supports.

In line with the attitude of the standards committee during recent years in urging greater activity by the technical committees in the standards field, a plan has been suggested which should not only lead to a co-ordination of the standards work of those committees, but also provide for the continued development of that work from year to year.

UNITED STATES NATIONAL COMMITTEE OF THE IEC

The United States National Committee has been saddened during the past year by the death of its honorary president, Doctor Arthur E. Kennelly, and also of James Burke, one of its most prominent members and a past president of the International Electrotechnical Commission. Doctor Kennelly, who was also an honorary president of the commission, served as technical advisor to the USNC on several subjects. The loss of these two valued members will be keenly felt by the USNC.

The 1939 annual meeting of the USNC elected Doctor Clayton H. Sharp honorary president of the committee and E. C. Crittenden, representing the National Bureau of Standards, president. L. F. Adams, representing the National Electrical Manufacturers Association, was elected vice president and Doctor H. S. Osborne, representing the AIEE, was re-elected vice president and treasurer.

Because of the European situation, the work of the International Electrotechnical Commission, and consequently of the USNC, has been considerably curtailed. However, the general secretary of the IEC has advised the national committees that the central office intends to carry on as much work by correspondence as possible under existing conditions, and hopes to issue, as provisional IEC recommendations, those documents which had been circulated under the six months rule prior to the beginning of the war. These are: Specifications for Transformers (excluding instrument and testing transformers); Specifications for the Resistivity of Aluminum; Specifications for Porcelain Insulators for Overhead Lines of 1,000 V and Upwards; Specifications for Safety Requirements for Electric Mains-operated Radio Receiving and Amplifying Apparatus; Revision of Publication 42, Part 3, Graphical Symbols for Weak-current Installations; Rules for the Measurement of Test-Voltages by Sphere-Gaps in Dielectric Tests, Appendix to IEC Publication No. 46 on Steam Turbines—Supplementary Notes to Section 4 Instruments and Methods of Measurement.

The meetings of the IEC advisory committees which had been scheduled for September 1939 in New York have been indefinitely postponed. However, these meetings will be held in New York eventually, after world conditions have returned to normal.

Hydraulic Turbines, IEC 4. The USNC, as secretariat of the IEC committee on hydraulic turbines, has prepared proposed specifications for hydraulic turbines including rules for acceptance tests. These documents have been sent to the central office of the IEC for transmission to the national committees for their comments.

Rating of Rivers, IEC 14. At the last meeting of the committee of action of the IEC, held in Paris in June 1939, it was agreed by implication that the IEC project on rating of rivers should be abolished because the committee had ceased to function. The USNC has registered with the central office of the IEC an objection to the abolishing of this committee, with the information that there appears to be a good likelihood that an American standard will be adopted and that a further effort should be made to reach international agreement.

Rules for the Measurement of Test-Voltage by Sphere Gaps in Dielectric Tests. Early in 1939, there was circulated to the national committees of the IEC a document giving draft rules for the measurement of test voltage by sphere gaps in dielectric tests, which had been prepared following the Torquay meeting in 1939. Comparison showed considerable differences in these proposed IEC standards from the standards in common use in this country. It was deemed desirable, therefore, that the matter be reopened within the IEC sphere gap subcommittee, and a meeting was arranged in Paris in July 1939. This meeting was attended on behalf of the USNC by P. L. Bellaschi. It was agreed that certain modifications should be made in the proposed standards. The modifications were to be carried out by the British, German, and American representatives. This decision has opened the question of sphere-gap standards again in such a way that it will be possible for a general compromise satisfactory to the USNC to be arrived at.

COMMITTEE ON PLANNING AND CO-ORDINATION

The comprehensive report of the committee dated April 3, 1939, was presented at the meeting of the board of directors held on May 26, 1939. Recommendations regarding discussion of social and economic questions, presentation and publication of papers, financial support of research, and nominations procedure were approved. The president was authorized to refer any or all of the remaining topics in the report to regular or special committees for further study and report.

The committee held meetings in October and January, and considered many topics which had been referred to it by the board of directors, or the president, or received from other sources. It made recommendations to the board of directors on a considerable number of matters involving a wide range of Institute activities, and has others still under consideration. Additional topics have come to it, and an all-day meeting will be held on May 23.

The committee, as usual, invited District and Section officers to submit requests for any national conventions and District meetings desired in the calendar year 1941, and prepared a schedule of such meetings which was approved by the board of directors in January.

COMMITTEE ON LEGISLATION AFFECTING THE ENGINEERING PROFESSION

At the start of the administrative year, the committee on legislation affecting the engineering profession absorbed the special committee on model law for registration of engineers. In June 1939, the AIEE model law was endorsed by the Board of Directors. Committee activity during the 1939–40 year has been limited to following up the discussion of this law and correspondence with engineers regarding proposed legislation in the various states.

Copies of the AIEE model law were circulated to various groups for comment. Much favorable comment has resulted and a small amount of adverse criticism. In some states principles underlying the AIEE model law are being drafted into proposed legislation.

Following the committee's recommendation, a number of AIEE Sections have appointed committees on legislation to keep posted regarding licensing activity in their states and to support or oppose according to local opinion. It is highly desirable that all Sections appoint such committees. Sections should afford all AIEE members opportunity to review personally proposed legislation, so that any position taken by a Section may be the considered majority opinion after full discussion. It should also be recognized that the scope of such committees should be confined to legislation affecting the profession.

The AIEE committee on legislation affecting the engineering profession desires to be kept informed by Sections on local activity in licensing.

COMMITTEE ON CONSTITUTION AND BYLAWS

The committee interpreted several sections of the bylaws referred to it, resulting in amendments to the bylaws. There were no meetings of the committee, the work being conducted by correspondence.

COMMITTEE ON ECONOMIC STATUS OF THE ENGINEER

The committee was very glad to co-operate with the similar committee of The American Society of Mechanical Engineers under the chairmanship of Dean C. J. Freund, in a consideration of unionization of engineers. This took the form of a paper on this topic by James H. Herron in *Mechanical Engineering* for November 1939, and discussions in the January 1940 issue of the same magazine. Professor Sorensen has contributed a discussion which is planned for the June issue of ELECTRICAL ENGINEERING.

The chairman of the Institute committee was appointed a member of Mr. Bickelhaupt's AEC committee on engineering and allied technical professions. Since similar appointments were made representing the American Society of Civil Engineers, the ASME, and the Washington Society of Engineers, an opportunity was presented to co-ordinate the efforts of the several committees dealing with the economic status of the engineer.

During the year great interest developed in a request for knowledge of the classification and salaries of electrical engineers particularly on the part of the younger members of the Institute and of faculty and industrial personnel officers. Analyses made by Dean F. M. Feiker of the distribution of engineers by industry indicate that more than 40 per cent of all civil engineers are employed by federal, state, and local governments; fewer than 3 per cent of electricals and mechanicals are so employed. Thus there is a distinct difference in the personnel problems of the three Founder Societies, and the subject is a very difficult one. Nevertheless, the Pittsfield Section of the Institute has studied the matter intensively during the year, and has requested more data and information. In order to explore the field and see if there is any basis for uniformity in the classifications and ranges in various industries which might be fairly representative of the profession as a whole, President Farmer has appointed a committee under the chairmanship of A. C. Stevens to obtain information and report its findings to the board.

COMMITTEE ON AWARD OF INSTITUTE PRIZES

Four national and eight District prizes were awarded for papers presented during the calendar year 1939 and for the student papers presented during the academic year ending June 30, 1939.

The committee considered a large number of eligible papers which were of a high quality, and, in determining the awards for the national best paper prizes and initial paper prize, it had the benefit of the gradings and recommendations of the technical committees which had reviewed the papers. In addition to the national paper prize awards, six other papers were given honorable mention.

On recommendation of the committee on award of institute prizes, the board of directors approved changes in the rules governing the award of all District prizes. These changes permit consideration of all papers for each prize subsequent to the periods covered by the last previous awards.

COMMITTEE ON SAFETY

The committee on safety continued the discussion of a number of subjects related to electrical safety during the year. One meeting of the committee was held during the year, and other matters have been handled through correspondence.

A paper on "Safe Practices in College Laboratories," prepared by M. S. Coover of Iowa State College, was presented at the annual meeting of the Society for the Promotion of Engineering Education in June 1939. The committee understands that the National Safety Council is now preparing a pamphlet on this subject for inclusion in its standard safe practice series.

The committee was represented by its chairman at an open meeting held during the National Safety Congress in October 1939, to review the NSC Safe Practice Pamphlet on Portable Electrical Hand Tools, prior to the development of a revised edition.

Inasmuch as it has not been practicable to print an AIEE pamphlet on artificial respiration due to the expense involved, an effort was made to secure sufficient copies of such material from the American Red Cross. A review of the Red Cross material indicated that it contained many phases of first aid, in addition to artificial respiration instruction, and was probably too voluminous for the purpose intended by the committee. Copies of a small pamphlet issued by the American Gas Association and the Edison Electric Institute will be asked for by the committee for use in making contacts with colleges and Student Branches concerning the development of resuscitation instruction.

A subcommittee has been appointed to develop further contacts with colleges and Student Branches in co-operation with the committee on Student Branches, and another subcommittee has been appointed to develop further contacts with the AIEE Sections on matters pertaining to electrical safety.

After a discussion of accidents in the medical field, the chairman and secretary of the committee agreed to inquire, through individual contact, regarding any steps which may have been taken by the medical fraternity to reduce accidents in handling electrical medical equipment.

COMMITTEE ON AUTOMATIC STATIONS

The committee on automatic stations held two meetings during the year, and sponsored the presentation of two papers at the summer and Pacific Coast convention and one paper at the winter convention.

COMMITTEE ON BASIC SCIENCES

The committee on basic sciences has reviewed eight papers, and has four in process of review. One-half of a session at the winter convention was sponsored by the committee, and it will provide papers for one-half of a session at the summer convention. A technical conference on definitions was held at the winter convention, and a conference on nonlinear analysis will be held at the summer convention.

COMMITTEE ON COMMUNICATION

Under the sponsorship of the committee on communication 16 technical papers on communication were presented at the summer-Pacific Coast convention, the winter convention, and the District meetings in Springfield and Minneapolis, and technical conferences were held at the two national conventions. Much attention has been given to radio subjects, and 8 of the 16 papers mentioned above deal specifically with radio. Several others are of interest to specialists in that field. A communication session at the summer-Pacific Coast convention was sponsored jointly with the Institute of Radio Engineers, and another joint session will be held at the 1940 Pacific Coast convention. A paper on frequency modulation, with demonstrations, will be presented at the summer convention.

COMMITTEE ON EDUCATION

The principal effort of this committee has been devoted to considering, planning, and putting into effect a program which might be continued into future years. As early steps in this direction, an outline of suggested activities was considered, and an inquiry regarding the desirability of organizing committees on education in the Sections was sent to the Section chairmen. On account of the generous response from the Sections and their keen interest in educational activities, a subcommittee was formed to secure detailed information on efforts of an educational nature intended to aid young engineers, and to make it available to all Sections. Two other subcommittees were organized: one to study vocational guidance activities of the Sections, and the other to secure, for publication in ELECTRICAL ENGINEERING, papers of an educational character of special interest to younger members. The committee hopes to make a significant contribution at the 1941 summer convention.

COMMITTEE ON ELECTRICAL MACHINERY

Five of the seven subcommittees of this committee have been active in developing and revising standards and test codes. The committee supplied three papers on "Hydrogen-Cooled Turbine Generators" for the North Eastern District meeting held in Springfield, Mass., in May 1939, and sponsored one session at the summer-Pacific Coast convention, and two sessions at the winter convention. A session and a technical conference on test codes at the 1940 summer convention will be sponsored by the committee.

COMMITTEE ON ELECTRIC WELDING

A session on welding sponsored by this committee at the 1940 winter convention created a large amount of interest. The committee has been devoting itself to the advancement of an educational program for extending co-operation among the manufacturers of welding equipment, the users, and the power companies to the end that good welding results may be secured at minimum first cost and operating cost. Parts I and II of a subcommittee report entitled "Power Supply for Resistance-Welding Machines" was presented at the winter convention, and several thousand reprints are being distributed.

COMMITTEE ON ELECTROCHEMISTRY AND ELECTROMETALLURGY

The committee held two meetings, and sponsored a joint symposium on power in the electrochemical industry by the Niagara Frontier Section of the Institute and the Niagara Falls section of the Electrochemical Society. It is planning a technical session for the 1941 winter convention in co-operation with the American Society of Metals. A subcommittee is investigating the effects of overvoltage in connection with large electrochemical and electrometallurgical installations.

COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT

A report, "Progress in Production and Application of Light" was published, in the name of the committee, in the December issue of ELECTRICAL ENGINEERING. A demonstration lecture based on the report, together with addresses on lighting of the New York World's Fair and the New York Municipal Airport, constituted a session at the winter convention. The planning of and the soliciting of papers for this program constituted one of the major activities of the committee. The attendance, and the reception of the papers were most gratifying. Several additional papers have been reviewed and approved for presentation at the summer convention. The committee has collaborated with the editor in obtaining special articles for ELECTRICAL ENGINEERING, and has a subcommittee which furnishes items of news interest. It has collaborated with the illumination group of the New York Section in organizing meetings for the discussion of lighting practice and developments in illuminating engineering.

COMMITTEE ON APPLICATIONS TO MARINE WORK

This committee has thoroughly reviewed standard No. 45, "Recommended Practice for Electrical Installations on Shipboard", through the work of 10 subcommittees. The editing committee is now preparing the recommended changes for submission to the standards committee.

COMMITTEE ON INSTRUMENTS AND MEASUREMENTS

The activities consisted primarily of reviews of technical papers, sponsorship of technical sessions at the two national conventions, preparation of reports on various phases of the progress of the art, and revision and extensions of AIEE standards. Material is being prepared for a comprehensive report on "Progress in the Art of Metering" covering electric power metering from its inception to the present day. A report on progress in telemetering is nearing completion. A report on "Wave Form in Dielectric Testing and Power Factor Measurements" was submitted to the standards committee. A revision of Standard No. 4, "Measurement of Test Voltage in Dielectric Tests", was completed and was approved by the standards committee and the board of directors. The committee also has reviewed several test codes prepared by other Institute technical committees; is compiling a bibliography on dielectric measurements made in the field; and is surveying possible sources of papers on oscillograph technique.

COMMITTEE ON POWER GENERATION

The committee on power generation has sponsored nine technical papers and one committee report for the two national conventions and the District meeting in Springfield. The committee report was for the years 1932–39, and was presented at the winter convention. In the development of plans for next year, two papers, on load swings and stability, and turbine generator governing, are in preparation for informal presentation and discussion at a round-table conference at the summer convention, with the thought that this procedure will aid in the selection of subjects for the 1941 winter convention.

COMMITTEE ON POWER TRANSMISSION AND DISTRIBUTION

One session at the summer-Pacific Coast convention and two sessions at the winter convention were sponsored by the committee. At a meeting of the committee, in September, the discussion of general organization work was followed by a prearranged discussion of engineering developments in the field of the committee. Such discussions have been of great interest to the members. A subcommittee has nearly completed a revision of standard No. 41, Insulators. A joint subcommittee representing three technical committees is preparing standards for bushings. A joint subcommittee is being organized to revise the grounding report prepared in 1931. A subcommittee is studying the advisability of a reorganization of committee on power transmission and distribution to meet present-day needs more effectively.

COMMITTEE ON PROTECTIVE DEVICES

The committee on protective devices has four subcommittees handling important divisions of its activities: circuit breakers, switches, and fuses; lightning arresters; relays; and fault-current-limiting devices. Each has carried on work in the development of standards and in other studies. Several standards have been substantially completed. A fifth subcommittee is co-operating with the committees on electrical machinery and power transmission and distribution. The committee sponsored three sessions on protective devices at the 1940 winter convention, one session and two technical conference papers at the summer-Pacific Coast convention, and one paper at each of the District meetings in Springfield and Minneapolis, with a total of 23 papers presented. A progress report is expected to be ready for the summer convention.

COMMITTEE ON RESEARCH

The principal activity of the committee on research has been in connection with service for the Institute as sponsor of two research projects supported by the Engineering Foundation: No. 66, Stability of Impregnated Paper Insulation, at Johns Hopkins University, and No. 74, Insulating Oils and Cable Saturants, at the Massachusetts Institute of Technology. Consideration has been given to the problems of the research method to ascertain whether there is sufficient interest to justify arrangements for a symposium on this subject. No definite conclusion has been reached. Efforts have been made to continue an activity started several years ago for the preparation of occasional news items on research subjects for ELECTRICAL ENGINEERING.

COMMITTEE ON TRANSPORTATION

The greater part of the work of the committee on transportation has been concerned with arranging to have papers written, reviewed, and presented at conventions. An effort has been made to have them cover the entire field of electrical engineering applied to transportation, and those presented at the winter convention covered a wide range of subjects with excellent discussion. The committee voted to initiate action toward having American tentative standard for railway motors (AIEE No. 11) advanced to status of full standard. At the invitation of the New Zealand Institution of Engineers, the committee also sponsored the preparation of a paper "Modern Rail Transport", by A. M. Wright of the Reading Railroad, for presentation at the New Zealand Centennial Engineering Congress scheduled for February 1940, but later cancelled on account of the war. The paper will be presented at the summer convention.

CHARLES LE GEYT FORTESCUE FELLOWSHIP COMMITTEE

A fellowship for graduate study in electrical engineering was established as a memorial to the late Charles LeGeyt Fortescue "in recognition of his valuable contributions to the electric power industry". The Westinghouse Electric and Manufacturing Company, with which Dr. Fortescue was associated throughout his professional life, set up a trust fund of $25,000 for this purpose.

The income will be administered by the Charles LeGeyt Fortescue fellowship committee of the Institute, and will provide fellowships of $500 or more to candidates selected annually by the committee. A bachelor's degree from an accredited college is a prerequisite, and the holders of the fellowships are expected to carry on their graduate studies in accredited engineering schools and to engage in research problems meeting the approval of the committee.

The first fellowship (1940–41) was awarded in March to Norman Z. Alcock, a senior in Queens University, Kingston, Ontario, who expects to engage in graduate study at the California Institute of Technology, Pasadena.

COMMITTEE ON AWARD OF COLUMBIA UNIVERSITY SCHOLARSHIPS

Seven formal applications were made for this scholarship, and from these the committee selected Cecil Clay Clements, a graduate of Alabama Polytechnic Institute. Mr. Clements qualified and registered in September, and pursued his studies during the winter session. However, in January, his father was taken very sick, and he was obliged to give up his work at Columbia, resigning the scholarship, and returning to his home.

The scholarship was not filled during the spring session because of the difficulty of making transfers in the middle of the academic year.

EDISON MEDAL

The Edison Medal, which is awarded by a committee composed of 24 members of the Institute, was, for 1939, awarded to Philip Torchio "for distinguished contributions to the art of central station engineering and for achievement in the production, distribution, and utilization of electrical energy", and was presented on January 24, 1940, during the winter convention. The medal may be awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts".

JOHN FRITZ MEDAL

The John Fritz Medal board of award, composed of representatives of the national societies of civil, mining, mechanical, and electrical engineers, awarded the 36th medal (for 1940) posthumously to the late Doctor Clarence F. Hirshfeld, formerly chief of the department of research, Detroit Edison Company, "for notable leadership through research and development in power generation and electric traction and for being a great teacher and friend of men both young and old".

LAMME MEDAL

The Lamme Medal committee awarded the medal for 1939 to Norman W. Storer, retired consulting railway engineer, Westinghouse Electric and Manufacturing Company, "for pioneering development and application of equipment for electrical traction". Arrangements are being made for the presentation of the medal at the summer convention in Swampscott, Mass., June 24–28, 1940. The medal may be awarded annually to a member of the AIEE "who has shown meritorious achievement in the development of electrical apparatus or machinery".

ALFRED NOBLE PRIZE

This prize, established in 1929, consists of a certificate and a cash award of $500 from the income from a fund contributed by engineers and others to perpetuate the name and achievements of Alfred Noble, past president of the American Society of Civil Engineers and of the Western Society of Engineers. It may be made to a member of any of the co-operating societies, ASCE, AIME, ASME, AIEE, or WSE, for a technical paper of particular merit accepted by the publication committee of any of these societies, provided the author, at the time of such acceptance, is not over 30 years of age. The award for 1939 was presented to C. E. Shannon (A'39) for his paper on "A Symbolic Analysis of Relay Switching Circuits".

WASHINGTON AWARD

The Washington Award for 1939 was bestowed upon Daniel Cowan Jackling, "for pioneering in large-scale mining and treatment of low-grade copper ores, releasing vast resources from formerly worthless deposits", and was presented to him at a dinner on April 15, 1940. This award may be made annually to an engineer by the commission of award composed of nine representatives of the Western Society of Engineers and two each of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, and AIEE.

HOOVER MEDAL

The Hoover Medal was established through a trust fund created by a gift from Conrad N. Lauer, and is to be awarded periodically "to a fellow engineer for distinguished public service" by a board representing the national societies of civil, mining and metallurgical, mechanical, and electrical engineers. The fourth recipient of this medal was Doctor Gano Dunn, who was cited as "Long honored by his fellow engineers for professional achievement, he has, beyond that, exemplified high civic purpose and a devotion to public service which have earned for him the Hoover Gold Medal for 1939".

IWADARE FOUNDATION COMMITTEE

No Iwadare lecturer was chosen to go to Japan for the current year, nor has any Iwadare Fellow come to the United States.

EMPLOYMENT SERVICE

The Institute co-operates with the national societies of civil, mining, and mechanical engineers in the operation of the Engineering Societies Employment Service with its main office in the Engineering Societies Building, New York. Offices are operated in Chicago and San Francisco also. In addition to the societies named, others co-operate in certain of the offices as follows: New York—Society of Naval Architects and Marine Engineers; Chicago—Western Society of Engineers; San Francisco—California Section of the American Chemical Society and the Engineers' Club of San Francisco.

The service is supported by the joint contributions of the societies and their individual members who are benefited. In addition to the publication of the employment service announcements monthly in ELECTRICAL ENGINEERING, weekly subscription bulletins are issued for those seeking positions.

An analysis of this employment service as reported to the national societies is given in table XIII.

AMERICAN ENGINEERING COUNCIL

The American Engineering Council has continued to carry on a wide range of activities within the scope of its objectives: "to further the public welfare wherever technical and engineering knowledge and experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions".

The broad range of the Council's activities is indicated by the titles of its committees: *Standing*—constitution, by-laws and standing rules, engineering and allied technical professions, finance, membership and representation, publicity and publications, regional activities, and public affairs; *Special*—patents, public works, surveys and maps, engineering economics, and inter-American engineering relations.

At the 20th annual meeting of the assembly held in Washington, D. C., January 11 and 12, 1940, a wide range of subjects received consideration. The 10th conference of secretaries of engineering societies was held on January 11 in connection with the meeting of the assembly.

It was reported at the annual meeting that the joint patent inquiry conducted under the sponsorship of the Council, the National Association of Manufacturers, and the National Industrial Conference Board, with funds supplied by NAM, had been nearly completed, and the report would be submitted to the sponsoring organizations within a few weeks.

A joint committee has been considering the reorganization of the Council in an effort to provide for "a combined professional approach to both public problems and interprofessional problems".

UNITED ENGINEERING TRUSTEES, INC.

This organization is the corporate body which holds title in the name of the four Founder Societies to their joint physical properties, namely, the Engineering Societies Building, the Engineering Societies Library, and the endowment funds of the Engineering Foundation. It operates and manages the Engineering Societies Building and administers certain joint activities of the four Founder Societies.

An abstract of the annual report of the UET, Inc., for the year which ended September 30, 1939, was published in ELECTRICAL ENGINEERING for December 1939, pages 531–2.

During the year, the "History, Charter, and Bylaws" was revised and brought up to date, new heating controls were installed in the Engineering Societies Building, and improvements in the ventilation of the meeting halls were made.

The John Fritz Medal Fund Corporation and the Daniel Guggenheim Medal Fund, Inc., dissolved their corporations and became committees of UET, Inc., which had, for a long period, managed the funds of the former and the books of the latter.

Table XIII. Analysis of Employment Service

Month	Men Registered				Men Placed			
	New York	Chicago	San Francisco	Total	New York	Chicago	San Francisco	Total
1939								
May	143	84	100	327	52	30	12	94
June	181	111	78	370	43	27	17	87
July	178	69	51	298	42	18	9	69
August	158	76	81	315	47	18	22	87
September	141	75	93	309	62	20	23	105
October	217	68	76	361	46	25	23	94
November	219	63	61	343	51	18	15	84
December	165	52	61	278	35	22	26	83
1940								
January	213	68	95	376	51	30	22	103
February	204	83	65	352	45	19	17	81
March	222	80	97	399	50	17	24	91
April	210	89	100	399	51	14	22	87
Total	2,251	918	958	4,127	575	258	232	1,065

ENGINEERING FOUNDATION

The Engineering Foundation is a joint organization of the national societies of civil, mining and metallurgical, mechanical, and electrical engineers established for "the furtherance of research in science and engineering, and the advancement in any other manner of the profession of engineering and the good of mankind".

A comprehensive abstract of the annual report of the Engineering Foundation for the year which ended September 30, 1939, was published in ELECTRICAL ENGINEERING for December 1939, pages 533–4, including information on each of a wide range of technical researches receiving support or assistance from the Foundation.

The research on "Stability of Impregnated-Paper Insulation" at the Johns Hopkins University is sponsored by the Institute. The work of the "Welding Research Committee" is sponsored by the American Welding Society and the Institute. The Foundation recently has granted support for a research on "Insulating Oils and Cable Saturants", at the Massachusetts Institute of Technology, under the sponsorship of the AIEE.

Assistance in nontechnical matters related to engineering has been granted to the Engineers' Council for Professional Development.

ENGINEERING SOCIETIES LIBRARY

The Engineering Societies Library, which was formed by combining the separate libraries of the four national societies of civil, mining and metallurgical, mechanical, and electrical engineers, and the preparation of a composite card catalog, has been expanded as a single engineering library, which probably constitutes the best collection of its type in the United States.

On September 30, 1939, the library had 146,999 volumes, 7,564 maps, and 4,440 bibliographies. Books, pamphlets, and maps totaling 15,914 were received during the year ending at that time. Current issues of 1,340 periodicals were received. Work progressed rapidly on a classified index to periodicals, and the index now contains more than 242,000 references to articles published since 1927.

Special services rendered by the library include: photoprints, searches, abstracts, translations, bibliographies, book loans by mail, etc. An abstract of the annual report of the library appeared on page 532 of ELECTRICAL ENGINEERING, December 1939.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

This council was organized in 1932 to engage in activities leading to the enhancement of the professional status of the engineer. It includes three representatives of each of the seven participating organizations: the national societies of chemical, civil, electrical, mechanical, and mining and metallurgical engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

The principal activities of ECPD include programs for the guidance of young individuals thinking of entering the engineering field, the accrediting of curricula of engineering schools, encouragement and assistance to individuals in their engineering and cultural studies during several years after graduation, and the development of criteria for indicating the attainment of the status of an engineer.

At the annual meeting held on October 20, 1939, the committee on engineering schools presented recommendations on 7 curricula, in four institutions, not previously acted upon, 74 curricula which had been provisionally accredited, and 9 curricula which had been rejected. It reported that 144 out of the total of 150-odd degree-granting engineering institutions had applied for inspection. The actions taken at that meeting brought the total number of curricula acted upon to 687, divided as follows:

Accredited unconditionally	433
Accredited for limited periods	82
Not accredited	172
Total	687

The complete list of accredited curricula appeared on page 526 of the December 1939 issue of ELECTRICAL ENGINEERING. A report on the annual meeting was published in the November 1939 issue of ELECTRICAL ENGINEERING, page 485.

REPRESENTATIVES

The Institute has continued its representation upon many joint committees and national bodies, with which it co-operates in a wide range of activities of interest and importance to engineers and others.

A list of representatives was published in the September 1939 issue of ELECTRICAL ENGINEERING and in the 1940 Year Book.

FINANCE COMMITTEE

The preparation of the annual budget is one of the major duties of the finance committee. The budget for the current year (beginning October 1) has some interesting features.

While the European War results in appreciable loss in revenue to the Institute, the steady growth in membership is expected to offset this influence, and it is anticipated that the revenues for the year will be substantially the same as for last year. By careful attention to economy in some items and by estimating closely the necessary expenses it has been possible in the current budget to provide for carrying on the activities of last year and for the expansion of these activities in some respects. Provision was made for about a 10 per cent increase in the Institute publications and for the addition to the headquarter's staff of one engineer whose time is largely devoted to standards work. The allowance for traveling expenses for delegates to Institute meetings and to District conferences was made more nearly adequate. An item of especial interest is the establishment of a pension reserve fund by the initial payment into this fund of $5,000 as a part of the current year's expenses. This is done as a first step toward the eventual establishment of a pension system for superannuated employees.

Under advice of investment counsel, the investments representing the reserve funds of the Institute are for the present being kept in fluid condition, cash and short-term bonds representing about one-half of the total.

Haskins and Sells, certified public accountants, have audited the books, and their report follows.

APPRECIATION

The board of directors again expresses to the national committees and the District, Section, and Branch officers its sincere thanks for their effective conduct of the activities in these important divisions. Their leadership has continued to produce a high degree of enthusiasm and constructive accomplishment. The board of directors also deeply appreciates the generous interest and support which the members have accorded its efforts on their behalf.

Respectfully submitted for the board of directors.

H. H. HENLINE,
National Secretary

May 24, 1940

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

22 EAST 40TH STREET
NEW YORK

May 16, 1940

American Institute of Electrical Engineers,
33 West 39th Street, New York.

Dear Sirs:

We have made an examination of your balance sheet as of April 30, 1940, and of your recorded cash receipts and disbursements for the year ended that date. Our examination consisted of a review of the system of internal control and the accounting procedures of the Institute and examination or tests of its accounting records and other supporting evidence by methods and to the extent we deemed appropriate. We present the following:

Balance Sheet, April 30, 1940 (Exhibit A).
    Property and Restricted Funds Securities, Less Reserve for Securities of Doubtful Value (Schedule 1).

Statement of Recorded Cash Receipts and Disbursements of General Fund for the Year Ended April 30, 1940 (Exhibit B).

Statement of Recorded Cash Receipts and Disbursements of Property and Restricted Funds for the Year Ended April 30, 1940 (Exhibit C).

In accordance with the terms of our engagement, members and other debtors, except certain advertisers, were not requested to confirm to us the amounts receivable from them at April 30, 1940. In accordance with the usual practice of the Institute, no provision has been made for dues which may prove to be uncollectible.

In our opinion, subject to the comments in the next preceding paragraph, the accompanying Exhibit A fairly presents your financial condition at April 30, 1940, and the accompanying Exhibits B and C fairly present your recorded cash receipts and your disbursements of funds, as indicated, for the year ended that date.

Yours truly,

HASKINS & SELLS

Exhibit A

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Balance Sheet, April 30, 1940

ASSETS		
Property Fund Assets:		
One-fourth interest in the total net assets of United Engineering Trustees, Inc., exclusive of Trust Funds	$498,448.48	
Equipment:		
Library—volumes and fixtures	37,296.37	
Office furniture and fixtures (less reserve for depreciation, $30,091.16)	4,973.26	
Works of art, etc.	3,001.35	
Securities—at cost (market quotation value, $6,505.45)—Schedule 1	6,355.45	
Cash (see Exhibit C)	3,330.32	
Total property fund assets		$553,405.23
Restricted Fund Assets:		
Securities—at cost, less reserve for securities of doubtful value (market quotation value, $177,352.94)—Schedule 1	$190,237.27	
Cash (see Exhibit C)	50,256.80	
Accrued interest receivable	69.99	
Total restricted fund assets		240,564.06
Current Assets:		
Cash (see Exhibit B)	$ 32,156.58	
Accounts receivable:		
Members—for dues	19,921.28	
Advertisers	518.40	
Miscellaneous	3,596.94	
Accrued interest on investments	1,588.72	
Inventories:		
Transactions, etc.	2,040.50	
Text and cover paper	5,746.61	
Work in process (May issue of Electrical Engineering)	3,887.76	
Badges	1,013.47	
Total current assets		70,470.26
Total		$864,439.55

LIABILITIES		
Property Fund Reserve		$553,405.23
Restricted Fund Reserves:		
Reserve Capital Fund	$221,074.78	
Life Membership Fund	8,772.17	
International Electrical Congress of St. Louis Library Fund	5,324.28	
Lamme Medal Fund	4,364.00	
Mailloux Fund	1,028.83	
Total restricted fund reserves		240,564.06
Current Liabilities—Accounts payable		11,396.55
Pension Fund Reserve		5,000.00
Deferred Income:		
Dues received in advance	$ 4,782.92	
Entrance fees and dues advanced by applicants for memberships	602.35	
Deferred credits for other unallocated receipts	396.39	
Subscriptions for Transactions received in advance	25.00	
Reserve for prepaid subscriptions for Electrical Engineering	7,400.00	
Total deferred income		13,206.66
Surplus		40,867.05
Total		$864,439.55

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Statement of Recorded Cash Receipts and Disbursements of General Fund for the Year Ended April 30, 1940

Exhibit B

Cash on Deposit With The National City Bank of New York, May 1, 1939		$ 61,988.30
Receipts:		
Dues (including $89,982.00 allocated to Electrical Engineering subscriptions)	$200,311.85	
Advertising	31,430.83	
Transactions subscriptions	6,987.56	
Electrical Engineering subscriptions	10,466.04	
Miscellaneous publications (preprints, standards, Transactions index, etc.)	13,470.17	
Students fees	13,621.25	
Entrance fees	7,020.54	
Membership badges	1,753.25	
Transfer fees	1,060.00	
Interest on investments, less purchased interest	6,778.17	
Miscellaneous	15.16	
Total receipts		292,914.82
Total		$354,903.12
Disbursements:		
Publications expense:		
Electrical Engineering	$ 81,689.94	
Transactions	11,209.62	
Year Book	6,314.46	
Miscellaneous publications (preprints, standards, Transactions index, etc.)	16,194.55	
Institute meetings	13,468.22	
Institute Sections	41,832.11	
Institute Branches	3,446.16	
Edison Medal committee	176.86	
Finance committee	600.00	
Headquarters committee	208.60	
Membership committee	7,738.91	
Standards committee	5,888.71	
Technical committee	223.62	
Traveling expenses:		
Geographical Districts:		
Executive committees	2,946.01	
Vice-presidents	556.80	
Forward	$192,494.57	$354,903.12
Total—(Forward)		$354,903.12
Disbursements—(Forward)	$192,494.57	
Traveling expenses—(Continued):		
Branch counselors and chairmen	7,823.75	
President's appropriation	403.05	
Board of directors	7,476.38	
National nominating committee	953.88	
Administrative expenses	46,910.84	
Geographical Districts—best paper prizes	165.50	
Initial paper prizes	25.00	
Institute prizes	227.21	
American Engineering Council	7,741.66	
American Standards Association	1,500.00	
United Engineering Trustees, Inc.:		
Building assessment	10,984.80	
Library assessment	9,811.52	
Engineering Societies Employment Service	1,380.44	
Engineers' Council for Professional Development	1,275.00	
Engineering Foundation Projects:		
Insulating oils and cable saturants	250.00	
Welding research	250.00	
Research on impregnated paper insulation	250.00	
National Fire Protection Association—dues	60.00	
United States Committee of International Commission on Illumination	300.00	
Membership badges	1,687.36	
Legal services	250.00	
Hoover Medal	175.55	
John Fritz Medal	100.00	
Lamme Medal	30.57	
Model registration law	187.53	
Transfer to reserve capital fund	30,000.00	
Miscellaneous	31.93	
Total disbursements		322,746.54
Cash on Deposit With The National City Bank of New York, April 30, 1940		$ 32,156.58

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Statement of Recorded Cash Receipts and Disbursements of Property and Restricted Funds for the Year Ended April 30, 1940

Exhibit C

	Restricted Funds						
	Reserve Capital Fund	Life Membership Fund	International Electrical Congress of St. Louis Library Fund	Lamme Medal Fund	Mailloux Fund	Total Restricted Funds	Property Fund (Equipment Replacements)
Cash on Deposit With East River Savings Bank and The National City Bank of New York, May 1, 1939	$10,543.27	$3,841.26	$1,187.54	$148.73	$ 17.73	$15,738.53	$ 32.83
Receipts:							
Interest on bonds and dividends on stocks		$ 250.00	$ 207.39	$ 64.00	$ 45.00	$ 566.39	
Interest on bank balance		67.79				67.79	
Proceeds from sale and redemption of securities	$32,002.99		3,926.69		1,000.00	36,929.68	$8,697.49
Transfer from general fund	30,000.00					30,000.00	
Total receipts	$62,002.99	$ 317.79	$4,134.08	$ 64.00	$1,045.00	$67,563.86	$8,697.49
Total	$72,546.26	$4,159.05	$5,321.62	$212.73	$1,062.73	$83,302.39	$8,730.32
Disbursements:							
Annual withdrawal authorized in by-laws		$ 713.96				$ 713.96	
Gold and bronze replicas of Lamme Medal and certificate				$188.73		188.73	
Purchase of securities	$27,635.00		$4,437.50			32,072.50	$5,400.00
All other disbursements			26.50	10.00	$ 33.90	70.40	
Total disbursements	$27,635.00	$ 713.96	$4,464.00	$198.73	$ 33.90	$33,045.59	$5,400.00
Balance on Deposit With The National City Bank of New York and Various Savings Banks, April 30, 1940	$44,911.26	$3,445.09	$ 857.62	$ 14.00	$1,028.83	$50,256.80	$3,330.32

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Property and Restricted Funds Securities, Less Reserve for Securities of Doubtful Value, April 30, 1940

Schedule 1

		Restricted Funds					
	Principal Amount of Bonds or Number of Shares of Stock	Reserve Capital Fund	Life Membership Fund	International Electrical Congress of St. Louis Library Fund	Lamme Medal Fund	Total Restricted Funds	Property Fund (Equipment Replacements)
Railroad Bonds:							
Alleghany Corporation 20-year collateral trust convertible 5%, due 1949	$15,000.00	$ 10,627.50				$ 10,627.50	
Baltimore & Ohio Railroad Company 6% refunding and general mortgage series C, due 1995 (stamped)	12,000.00	8,940.00			$4,330.00	13,270.00	
Central of Georgia Railway Company 5% consolidated mortgage, due 1945	3,000.00	1,477.50				1,477.50	
Chicago & Erie Railroad Company 5% first mortgage, due 1982	1,000.00	1,105.00				1,105.00	
Chicago & Northwestern Railway Company 6$^1/_2$%, due March 1, 1936	9,000.00	7,202.50				7,202.50	
Florida East Coast Railway Company 5% first and refunding mortgage series A, due 1974 (certificates of deposit)	10,000.00	9,818.75				9,818.75	
New York Central Railroad Company 5% refunding and improvement mortgage series C, due 2013	6,000.00	5,742.50				5,742.50	
Northern Pacific Railway Company 6% refunding and improvement mortgage series B, due 2047	10,000.00	10,962.50				10,962.50	
St. Louis-San Francisco Railway Company 5% prior lien mortgage series B, due 1950 (certificates of deposit)	6,000.00	5,497.50				5,497.50	
Texas and Pacific Railway Company general and refunding series B 5%, due 1977	5,000.00		$5,306.25			5,306.25	
Western Pacific Railroad Company 5% series A, due 1946 (stamped)	15,000.00	7,225.00				7,225.00	
Total railroad bonds		$ 68,598.75	$5,306.25		$4,330.00	$ 78,235.00	
Public Utility Bonds:							
Edison Electric Illuminating Company of Boston 3$^1/_2$% first mortgage series A, due 1965	2,000.00			$2,222.50		$ 2,222.50	
Illinois Bell Telephone Company 3$^1/_2$% first and refunding mortgage series B, due 1970	2,000.00			2,215.00		2,215.00	
New York & Queens Electric Light & Power Company 3$^1/_2$% first and consolidated mortgage, due 1965	10,000.00	$ 11,000.00				11,000.00	
Total public utility bonds		$ 11,000.00		$4,437.50		$ 15,437.50	
FORWARD		$ 79,598.75	$5,306.25	$4,437.50	$4,330.00	$ 93,672.50	

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Property and Restricted Funds Securities, Less Reserve for Securities of Doubtful Value, April 30, 1940

Schedule 1 (Concluded)

	Principa Amount of Bonds or Number of Shares of Stock	Restricted Funds					Property Fund (Equipment Replacements)
		Reserve Capital Fund	Life Membership Fund	International Electrical Congress of St. Louis Library Fund	Lamme Medal Fund	Total Restricted Funds	
FORWARD		$ 79,598.75	$5,306.25	$4,437.50	$4,330.00	$ 93,672.50	
Industrial and Miscellaneous Bonds, Etc.:							
Fidelity Union Title and Mortgage Guaranty Company first mortgage certificates (on property 75–79 Prospect Street, East Orange, N. J.) 4%, due 1944	$14,329 77	$ 13,374.32				$ 13,374.32	$ 955.45
General Motors Acceptance Corporation 3¹/₄%, due 1951	7,000.00	7,140.00				7,140.00	
United States Steel Corporation debentures 3¹/₄%, due 1948	8,000.00	8,240.00				8,240.00	
Total industrial and miscellaneous bonds, etc.		$ 28,754.32				$ 28,754.32	$ 955.45
United States Government Bonds and Notes:							
Federal Farm Mortgage 3%, due 1949/44	12,000.00	$ 12,405.00				$ 12,405.00	
Treasury Bonds 3¹/₄%, due 1941	10,000.00	10,650.00				10,650 00	
Treasury Bonds 2³/₄%, due 1947/45	10,000.00	10,409.38				10,409.38	
Treasury Bonds 3³/₈%, due 1943/40	10,000.00	10,537.50				10,537.50	
Treasury Bonds 3³/₈%, due 1943/41	10,000.00	10,681.25				10,681 25	
Treasury Notes 2% series B, due September 15, 1942	21,000.00	21,756.57				21,756.57	
Treasury Savings Bonds series D, due July 1, 1949	10,000.00	2,100.00				2,100 00	$5,400.00
Treasury Savings Bonds series D, due January 1, 1950	10,000.00	7,500 00				7,500:00	
Total United States Government bonds and notes		$ 86,039.70				$ 86,039.70	$5,400.00
Capital Stocks:							
Commonwealth Edison Company	48 shares	$ 2,892.00				$ 2,892.00	
Commercial Investment Trust Corporation 4¹/₄% preferred, series of 1935	100 "	10,100.00				10,100.00	
International Match Realization Co., Ltd. voting trust certificates for capital shares of International Match Corporation	6 "	2,154.15				2,154.15	
Total capital stocks		$ 15,146.15				$ 15,146.15	
Total		$209,538.92	$5,306.25	$4,437.50	$4,330.00	$223,612.67	$6,355.45
Less Reserve for Securities of Doubtful Value:							
Central of Georgia Railway Company 5% consolidated mortgage, due 1945	$ 3,000.00	$ 1,477.50				$ 1,477.50	
Chicago & Northwestern Railway Company 6¹/₂%, due March 1, 1936	9,000.00	7,202.50				7,202.50	
Florida East Coast Railway Company 5% first and refunding mortgage series A, due 1974	10,000.00	9,818.75				9,818.75	
International Match Realization Co., Ltd. voting trust certificates for capital shares of International Match Corporation	6 shares	2,154.15				2,154.15	
St. Louis-San Francisco Railway Company 5% prior lien mortgage series B, due 1950	$ 6,000.00	5,497.50				5,497.50	
Western Pacific Railroad Company 5% series A, due 1946 (stamped)	15,000.00	7,225.00				7,225.00	
Total reserve for securities of doubtful value		$ 33,375.40				$ 33,375.40	
Total Property Fund Securities							$6,355.45
Total Restricted Fund Securities, Less Reserve		$176,163.52	$5,306.25	$4,437.50	$4,330.00	$190,237.27	

Board of Directors Meets

At its regular meeting at Institute headquarters, May 24, 1940, the AIEE board of directors approved the establishment of a technical committee on domestic and commercial applications, with the understanding that the statement of scope of the new committee will be prepared in co-operation with the technical program committee and will include the subject of applications to refrigeration.

Upon recommendation of the committee on planning and co-ordination, the board voted to change the status of the committee on research from that of a technical committee to that of a general committee. Effects of the change will be to eliminate some duplication of the activities of the other technical committees, which are in a measure concerned with research in their respective fields; to add functions intended to stimulate research activities along lines pertaining to the Institute; and to give research in electrical engineering a somewhat more general and representative status than it has had.

Recommendation of the committee on planning and co-ordination that the technical committees be encouraged to prepare special material in their respective fields for publication on a self-supporting basis was approved. The Lightning Reference Book, published under the auspices of the committee on power transmission and distribution, was mentioned as an outstanding example.

Referred to the incoming board were the report of the special committee on radio talks on electrical-engineering subjects, to be presented at the August meeting, and a progress report of the special committee on posthumous honors, recommendations of which were recommended for favorable action, provided the necessary financial support is available.

The board adopted a statement of "Institute Policy Concerning Standardization Activities" contained in a report on "AIEE and Standardization", made by F. Malcolm Farmer in accordance with action of the executive committee as a result of a request for a clarification of the relationship between the AIEE and the American Standards Association. The statement appears on page 306. Approval was given for publication of revisions of AIEE Standards No. 1, "General Principles Upon Which Temperature Limits Are Based in the Rating of Electrical Machinery and Apparatus", and No. 22, "Air Switches and Bus Supports".

Applications to the Engineering Foundation for continued support of three research projects during the year beginning October 1, 1940, were reported and confirmed. These are:

Project 66, Stability of Impregnated-Paper Insulation

Project 74, Insulating Oils and Cable Saturants

Project 62, Welding Research

The board authorized a Southern District meeting to be held in New Orleans in the fall of 1941, upon request of the District executive committee.

Establishment of a Student Branch at Norwich University, Northfield, Vermont, was authorized, upon recommendation of the committee on Student Branches.

A new style of Institute badge, a small key charm, was added to the list of Institute badges, and a revised price list of badges approved.

Amendments to Institute bylaws were adopted as follows:

Section 65, third paragraph amended by substitution of the word "additional" for the word "auxiliary" to read:

> "The president or the board of directors may appoint additional members to any committee."

Section 68, first paragraph amended by addition of the word "appointed" to read:

> "The technical program committee shall consist of nine appointed members, and the chairman of each technical committee, the chairman of the committee on planning and co-ordination, and the chairman of the committee on safety, ex officio."

Section 84, first sentence amended by addition of the word "appointed" to read:

> "The committee on Student Branches shall consist of five appointed members and the counselor of each Branch, ex officio, and shall have general supervision and management of the Student Branches of the Institute."

The board took the following action on appointments:

Reappointed **H. H. Henline** national secretary for the year beginning August 1, 1940.

Nominated **W. I. Slichter** to represent AIEE as a member of the Engineering Foundation board for the four-year term beginning in October 1940.

Appointed **John C. Parker** AIEE representative on American Engineering Council, succeeding C. E. Stephens, whose resignation was accepted.

Empowered the president to appoint a representative on the Washington Award commission for the two-year term beginning June 1, 1940.

Confirmed committee of tellers appointed by president for 1940 election, as follows: **E. C. Plant,** *chairman,* **H. H. Duehne, E. P. Ellis, O. T. Laube, J. E. Loehr, F. T. Meyer, S. H. Thomas.**

Appointed representatives recommended by standards committee, as follows:

Wray Dudley, Fred Schnure, W. E. Crawford, AIEE delegation, sectional committee on welding, *C*52.

W. B. Kouwenhoven, sectional committee on dry cells and batteries, *C*18, succeeding E. D. Doyle.

Edward Bennett, chairman of AIEE delegation, sectional committee on electric and magnetic magnitudes and units, *C*61, succeeding A. E. Kennelly, deceased.

Requested the committee on economic status of the engineer to appoint four AIEE representatives to participate in a national conference on engineering positions, in response to an invitation from the American Society of Civil Engineers.

Other action by the board included:

Annual report of the national treasurer for the fiscal year ending April 30, 1940, approved.

Draft of annual report of board of directors, submitted by the national secretary, approved for presentation at the annual meeting of the Institute at Swampscott, Mass., June 24, 1940, subject to suggestions for changes presented by members of the board prior to printing date.

Minutes of meetings of board of directors, January 23, 1940, and of executive committee, March 8, 1940, approved.

Executive committee action, as of April 12, 1940, confirmed, as follows: 2 applicants transferred to grade of Fellow; 15 transferred and 17 elected to grade of Member; 538 elected to grade of Associate; 96 Students enrolled.

Reports of board of examiners' meetings, March 14, April 18, and May 16, 1940, approved; action on recommendations as follows: 2 applicants reelected to grade of Fellow; 12 transferred and 23 elected to grade of Member; 483 applicants elected to grade of Associate; 261 Students enrolled.

Finance committee report: expenditures in March, $25,318.69; April, $20,829.23; May, $32,959.23; approved.

Those present were:

President—F. Malcolm Farmer, New York, N. Y.

Past President—John C. Parker, New York, N. Y.

Vice-Presidents—T. F. Barton, New York, N. Y.; C. L. Dawes, Cambridge, Mass.; F. R. Maxwell, Jr., University, Ala.; C. T. Sinclair, Pittsburgh, Pa.; J. M. Thomson, Toronto, Can.

Directors—C. R. Beardsley, H. S. Osborne, New York, N. Y.; Mark Eldredge, Memphis, Tenn.; R. E. Hellmund, C. A. Powel, Pittsburgh, Pa.; L. R. Mapes, Chicago, Ill.; K. B. McEachron, Pittsfield, Mass.; D. C. Prince, Schenectady, N. Y.; R. W. Sorensen, Pasadena, Calif.

National Treasurer—W. I. Slichter, New York, N. Y.

National Secretary—H. H. Henline, New York, N. Y.

Future AIEE Meetings

Pacific Coast Convention
Los Angeles, Calif., August 27–30, 1940

Middle Eastern District Meeting
Cincinnati, Ohio, October 9–11, 1940

Winter Convention
Philadelphia, Pa., January 27–31, 1941

New Key Charm Badge Available

A new article of Institute jewelry is the key charm AIEE badge approved by the board of directors at its meeting, May 24, 1940. The new badge, shown full size in the accompanying illustration, is now available on order from AIEE headquarters, 33 West 39th Street, New York, N. Y.; price $4.50. The price of the standard watch-charm AIEE emblem recently has been reduced from $5.00 to $4.50 also.

Additions to List of Members for Life

Membership for life is granted by the AIEE to members who either have paid annual dues for 35 years, or have reached the age of 70 and have paid dues for 30 years. A list of those who have become members for life during the preceding year is published annually in ELECTRICAL ENGINEERING. The following are the Institute members who have reached member-for-life status since publication of the last previous list in the July 1939 issue.

E. W. Ackland
John R. Anderson
D. F. Atkins
P. A. Baker
E. H. Bangs
H. Barker
T. W. Behan
B. J. G. S. Bergman
V. Boyd
W. C. Boyrer
A. M. Buck
H. D. Carpenter
G. F. Chellis
W. G. Clark
W. N. Clark
B. H. Clingerman
A. Coggeshall
Frank Conrad
J. S. G. Cooper
W. J. Crumpton
J. C. Damon
R. H. Dillon
R. T. Durran
H. C. Eddy
W. Elsdon-Dew
A. F. Enstrom
C. J. Fechheimer
T. Fitzgerald
C. W. Fletcher
H. C. Ford
D. L. Galusha
C. M. Garland
E. F. Gehrkens
C. P. Goepel
F. F. Grevatt
J. W. Hancock
F. C. Hanker
J. L. Hansen
H. V. Hayes
J. C. Hays
N. Hayward
R. E. Hellmund
J. S. Henderson
W. S. Higgins
L. L. Holladay
C. W. Humphrey
F. W. Hurlbert
C. M. Jansky
J. P. Jollyman
M. G. Kennedy
C. G. Kilbourne
E. D. King
C. T. Knipp
R. R. Lawrence
S. J. Lisberger
D. E. Manson
S. W. Mauger
G. K. McDougall
J. C. Mock
E. W. Muller
E. R. Northmore
I. H. Osborne
A. J. Pahl
H. R. Palmer
H. Parodi
W. M. Piatt
L. J. Pierce
A. Pirelli
N. Platt
H. J. Podlesak
W. G. T. Pope
H. A. Putnam
L. O. Ripley
F. A. Rogers
W. B. Sanford
T. G. Seidell
J. E. Sirrine
H. L. Smith
W. J. Smith
H. Clyde Snook
S. A. Spalding
C. W. Speirs
W. B. Spellmire
J. S. Stone
T. P. Strickland
J. O. Taylor
W. A. Thomas
A. N. Topping
C. E. Torrey
H. M. Van Gelder
H. L. Van Valkenburg
Theodore Varney
J. C. Vincent
H. C. Walter
K. W. Waterson
W. G. H. Whitaker
G. Wittig
Fay Woodmansee
H. W. Young

District • • • •

Seven Districts Announce Prize Awards for Papers

District prizes for AIEE papers have been announced by seven Districts to date. The awards are for papers presented during 1939, except Branch papers, which must have been presented during the academic year ending June 30, 1939, according to the revised rules adopted in 1937 and amended January 23, 1940.

District 1

Prize for best paper was awarded to D. S. Snell (A'24) for his paper "The Hydrogen-Cooled Turbine Generator," presented at the North Eastern District meeting, Springfield, Mass., May 3, 1939. Honorable mention was made of the paper "The Rectifier Calculus" by W. Melvin Goodhue (A'31) presented at the North Eastern District meeting, Springfield, Mass., May 5, 1939.

Prize for Branch paper was awarded jointly to W. N. Brown, Jr. (Enrolled Student) and E. W. Sheridan (Enrolled Student) for their paper "Frequency-Selective Feedback for Improvement of Acoustical Response of an Audio-Frequency Sound System" and to E. C. Dench (Enrolled Student) for his paper "The 'Glo-Relay,' a New Method of Initiating Vapor Discharges," presented at the North Eastern District meeting, Springfield, Mass., May 5, 1939.

District 3

Prize for Branch paper was awarded to Paul J. Reifschneider (Enrolled Student) for his paper "An Electronic Voltage Regulator for an Alternator," presented at a meeting of the Polytechnic Institute of Brooklyn Branch, Brooklyn, N. Y., April 20, 1939.

District 6

Prize for Branch paper was awarded to Jay W. Forrester for his paper "Electrostatic Dust Precipitators," presented at the annual student conference of District 6, Laramie, Wyo., April 21–22, 1939.

District 7

Prize for Branch paper was awarded to Robert B. Bonney (Enrolled Student) for his paper "Directional Antennas for Broadcast Stations," presented at the conference on student activities, South West District meeting, Houston, Tex., April 19, 1939.

Prize for graduate paper was awarded to Nejat Atsan (membership application pending) for his paper "A Method of Line-Voltage Control," presented at the conference on student activities, South West District meeting, Houston, Tex., April 19, 1939.

District 8

Prize for Branch paper was awarded to Thomas E. Curtis (A'40) for his paper "Compound Frequency Control of Power Systems," presented at summer and Pacific Coast convention, San Francisco, Calif., June 29, 1939.

Prize for graduate paper was awarded to Arthur E. Harrison (A'39) for his paper "Ionization Time of Thyratrons," presented at summer and Pacific Coast convention, San Francisco, Calif., June 27, 1939.

District 9

Prize for best paper and prize for initial paper were awarded to Herbert N. Steen (A'31) for his paper "A Three-Element Cathode-Ray Oscillograph," presented at a meeting of the Seattle Section, December 19, 1939.

Prize for Branch paper was awarded to Opal Cummins (membership application pending) and Willice Groves (A'37) for their paper "Water-Cooled Radio Frequency Amplifier With Grounded Anodes," presented at a joint meeting of the Utah Section and University of Utah Branch, Salt Lake City, May 22, 1939.

District 10

Prize for best paper was awarded to Hubert R. Sills (A'24, M'31) for his paper "Vertical Shaft Generators," presented at a meeting of the Toronto Section, January 27, 1939.

Prize for initial paper was awarded to Archie M. Doyle (A'37) for his paper "Lightning Protection for Power Transmission Systems," presented at a meeting of the Toronto Section, January 13, 1939.

District 8 Executive Committee

The executive committee of the Pacific District (8) met May 14, 1940, at Los Angeles, Calif., and discussed matters of routine business. Arrangements for the program of the conference on student activities, planned to be held at Los Angeles during the forthcoming Pacific Coast convention, were discussed, also the possibility of holding the 1942 Pacific Coast convention at San Diego, and other matters relating to planning conventions.

Commended as worthy of consideration by other Sections were the Los Angeles Section's practice of encouraging members to entertain Enrolled Students regularly at dinner meetings; and the San Francisco Section's policies of making new members guests of the membership committee at the first dinner meeting following election, and of encouraging continued interest by graduating Students, through letters sent well in advance of graduation, which encourage transfer to Associate grade, offer to notify the Student of meetings, and enclose a prepaid postcard for reply.

Branch • • • •

District 1 Convention at Rensselaer

The annual convention of Student Branches of the Northeastern District (1) was held at Rensselaer Polytechnic Institute, Troy, N. Y., May 3–4, 1940. Features of the convention were three technical sessions, inspection of the transformer plant and plastics division of the General Electric Company at Pittsfield, Mass., conference of counselors and chairmen, and a banquet at which District Vice-President C. L. Dawes was toastmaster and Doctor W. O. Hotchkiss, president of Rensselaer, AIEE President F. Malcolm Farmer, and E. S. Lee, nominee for vice-president of District 1, were speakers.

At the technical sessions on May 4, the following student papers were presented:

Graduate-student papers session: E. C. Dench, Massachusetts Institute of Technology, chairman

Reluctance-Motor Charactersitics, **H. deFritsch**, Harvard University

A New Concept in Communication, **W. N. Brown, Jr.**, Massachusetts Institute of Technology

Silver-Graphite Brushes, **H. M. Parshall**, Rensselaer Polytechnic Institute

A Sharp Cutoff Limitor, **J. J. Hagopian**, Worcester Polytechnic Institute

Magnetostriction Oscillators, **Herbert Krauss**, Yale University

Undergraduate papers session: measurements and general, S. K. Brown, Cornell University, chairman

Measurement of Quadrature-Axis Reactance, **H. T. Marcy**, Massachusetts Institute of Technology

Analysis of Impulse Voltages by Lichtenberg Figures, **Nickos Petrou** and **Frank Rosenkrans**, Northeastern University

The Sensitivity of Bridges, **C. A. Lister**, Tufts College

A Study of Fluorescent Lamps, **T. C. Muchmore**, Cornell University

Oscillographic Determination of Frequency-Response Curves, **R. M. Sills**, Yale University

Circuit for an Electronic Integrator, **J. H. Arthur**, Rensselaer Polytechnic Institute

"Psychogalvanometer," **J. L. Raesler**, Syracuse University

Electromagnetic System for Airplane Blind-Landing, **W. T. Gore** and **D. G. Howard**, Worcester Polytechnic Institute

Undergraduate papers session: communication and electronics, W. A. Knoop, Rensselaer Polytechnic Institute, chairman

The Brown Network, **D. W. Borst**, Brown University

Wide-Band Transmitter, **T. M. Ferrill, Jr.**, Massachusetts Institute of Technology

An Ultrahigh-Frequency Transmitter for Amplitude or Frequency Modulation, **Norman Caplan**, Rensselaer Polytechnic Institute

Wired Wireless Intercommunications, **A. A. MacDonald**, Yale University

Loud-Speaker Divider Network, **R. F. Scharmann**, Worcester Polytechnic Institute

A Remote-Control Dimmer, **R. E. Armington**, Tufts College

Electric and Magnetic Focusing of the Cyclotron Beam, **D. B. Hoisington**, Massachusetts Institute of Technology

Electronic Control of Thyratrons, **R. B. Russ**, Yale University

Speaking prizes, presented at a luncheon on May 4, were as follows: graduate session—first prize, J. J. Hagopian; measurements session—first prize, Nickos Petrou and Frank Rosenkrans, second prize, W. T. Gore and D. G. Howard; communications session—first prize, T. M. Ferrill, Jr., second prize, Norman Caplan. The District 1 award for best Branch paper for 1938–39, awarded jointly to E. C. Dench for his paper "The 'Glo-Relay', a New Method of Initiating Vapor Charges", written at Worcester Polytechnic Institute, and to W. N. Brown, Jr., and E. W. Sheridan, Massachusetts Institute of Technology, for their paper "Frequency-Selective Feedback for Improvement of Acoustical Response of an Audio-Frequency System", was presented at the banquet on May 3.

At the conference of Branch counselors and chairmen on May 4, the following were elected to the District committee on student activities for 1940–41: E. A. Walker, Tufts College, chairman; A. G. Conrad, Yale University; G. S. Brown, Massachusetts Institute of Technology. E. M. Strong, Cornell University, retiring chairman, was designated as District 1 counselor delegate to the summer convention at Swampscott, Mass.

The report "The Status of the Graduate Student in AIEE Student Branch Activities", copies of which had been distributed, was discussed in detail, with special consideration given the problems created by lack of uniform practice among schools in distinguishing graduate and undergraduate status, and in terminating Enrolled Student status for graduate students employed by the school. The meeting voted to refer the report back to the committee for revision, correction, and reconsideration, all counselors being urged to submit written comments or criticisms. The meeting voted in favor of July 15 as a closing date for student papers, and expressed itself as favoring the use of a student page in ELECTRICAL ENGINEERING for publishing abstracts of student papers winning District prizes.

Conference of District 7 Branches

The 15 Branches in the South West District (7) held the annual Student Branch conference April 19–20, 1940, at Texas Technological College, Lubbock, Tex. Technical sessions were held on both days at which papers were presented for the annual graduate and undergraduate competitions. Titles and authors of the papers presented were not available at publication time.

Winners in the competitions were announced at a luncheon on April 20, at which District Vice-President F. C. Bolton was a speaker. They were as follows:

Undergraduate competition—first place, Leroy Evans and Raymond Glass, Texas Technological College; second place, Dale W. Whitaker and Richard B. Scott, University of Kansas; third place, Roger K. Ghormley, Kansas State College. Graduate competition—first place, Luther E. Johnson, Texas A. and M. College; second place, Edwin A. Goldberg, University of Texas.

Counselors and Branch chairmen and chairmen-elect held a breakfast meeting on April 20, after which student officers and counselors held separate business meetings. The chairmen's meeting agreed to present a slide rule to Chairman C. F. Barnard of the Texas Technological College Branch, in recognition of his work in organizing the conference; voted to make reports on next year's plans early in the year and to distribute these to all Branch officers.

The business meeting of counselors voted to hold the 1941 student conference in connection with the South West District meeting since both are scheduled to be held in St. Louis, Mo. An invitation to hold the 1942 conference at the University of New Mexico, Albuquerque, was offered. J. S. Johnson, Missouri School of Mines and Metallurgy, Rollo, was elected chairman of the District committee on student activities for the coming year.

Methods of grading student papers were discussed at length. It was voted to have two groups of judges, one for graduate and one for undergraduate papers, in the future. The meeting later voted to have no formal judging or competition, but to require that papers be turned in two weeks before the date of the conference in order to be presented on the program, and to send two copies to each Branch. It was urged that more papers be submitted for national and District prize, in accordance with the suggestion of the AIEE committee on Student Branches.

After discussion of the desirability of a student page in ELECTRICAL ENGINEERING, the new chairman was requested to investigate methods of arranging for this space.

Joint Meeting at Stanford

The annual joint meeting of the three local Student Branches with the San Francisco Section was held at Stanford University, Calif., April 26, 1940. A demonstration of the 2,000,000-volt lightning generator at Ryan Laboratory and dinner at the Stanford Union preceded the meeting, which featured the annual competition for the student-paper prize presented by the San Francisco Section. The following papers were presented:

POWER SYSTEM CONTROL BY TELEMETERING, **Bernard Cassidy**, University of Santa Clara

TWO INSTRUMENTS TO INDICATE THE POLARITY OF HIGH-VOLTAGE SPARK DISCHARGES, **O. J. M. Smith**, Stanford University

SPEED-TORQUE CURVES OF MOTORS BY ACCELERATION METHODS, **C. N. Williamson**, University of California

The prize, one year's dues as an Associate in the Institute, was awarded to O. J. M. Smith. The contest was preceded by a talk by Vice-President H. W. Hitchcock of District 8, and followed by presentation of the sound film of Doctor Charles F. Scott being shown by many Branches this year in commemoration of their founder's 75th birthday.

Standards • • •

Institute Policy Concerning Standardization Activities

Acting on the suggestion of President Farmer, the following statement of policy concerning Institute standardization activities has been prepared for the information of the membership. It is intended to present a clear picture of scope and character of Institute activities, and their relationship to the work of the American Standards Association.

The statement has been discussed by the standards committee and approved at its meeting on March 26. The board of directors indicated its approval at its meeting of May 24.

Standardization in the electrical engineering field is an important element in the advancement of the art—one of the stated objectives of the Institute. Therefore the Institute should take a prominent and, where appropriate, leading part in all standardization activities with which electrical engineering is concerned.

DEVELOPMENT OF STANDARDS

With respect to the development of standards, the following is the general policy of the Institute, it being understood that certain situations may develop which will require departure therefrom:

1. The development of a standardization project idea anywhere in the Institute organization is encouraged. The proposal should, however, be referred to the standards committee for consideration and action.

2. The standards committee will then review the proposal and determine whether or not the idea should be taken up as an Institute project. If the decision is affirmative, the standards committee will decide whether to:

(*a*) submit at once a request to the American Standards Association that the proposed project be undertaken by the ASA under sectional committee procedure with the AIEE as either sole or joint sponsor, or

(*b*) develop the proposed standard solely as an AIEE project without reference to ASA or any other body, or

(*c*) carry on, solely as a standards committee activity, the preliminary developmental, research, or other strictly technical "spade" work that may be required, with the expectation that ultimately ASA approval will be asked under the existing standards method, the general acceptance method, or by the sectional committee method, whichever seems most appropriate.

PUBLICATION OF STANDARDS

The following is the general policy of the Institute with respect to publication of standards:

1. A standard shall be designated an AIEE Standard in the official list of AIEE Standards whenever it is approved by the Institute irrespective of the auspices under which it was developed. This designation would therefore apply to:

(*a*) standards developed solely by and within the Institute, which have not been submitted to ASA for approval by that body. They would carry an AIEE number only.

(*b*) standards developed as in group *a*, but approved by ASA. They would carry both AIEE and ASA numbers (which may be identical).

(*c*) standards developed under ASA sectional committee procedure when approved by the Institute and of course also by ASA. They would carry both AIEE and ASA numbers (which may be identical).

(*d*) standards developed under any other auspices which the Institute may wish to approve as AIEE Standards. They would carry the AIEE number.

2. The Institute will publish all standards in groups *a* and *b*. The Institute also will publish the standards included in group *c* where the Institute is sole sponsor, or in the case of joint sponsorship, where it is so arranged with the joint sponsor or sponsors. All standards published by the Institute are to be in a uniform style conforming as far as practicable with ASA "Proposed Form and Arrangement of Published Standard," and with uniform title pages.

3. The term "AIEE Standard," prominently printed on the title page of many Institute standards, is to be dropped and instead incorporated (prominently) in the serial number designation, thus, "AIEE Standard No. 45, December, 1938."

4. Drafts or reports of *proposed* standards should be published with a title-page format which clearly distinguishes them from standards. In general, in order to make this distinction more emphatic, such documents preferably should be produced by the offset process rather than by printing.

Personal • • •

N. H. Coit (A'19, M'27) formerly vice-president and general manager of the South Carolina Electric and Gas Company, Columbia, has been made president and general manager. Born in Indianapolis, Ind., December 9, 1894, he received the degree of bachelor of science in electrical engineering from the University of Colorado in 1917. He was employed by the Mountain States Telephone and Telegraph Company in Denver, Colo., and Salt Lake City, Utah, in 1917–18, and from 1918 to 1923 was superintendent of the Auburn, Nebr., plant of the Western Public Service Company. He became associated with the General Gas and Electric Corporation in 1923 as assistant commercial manager of the Pennsylvania Edison Company, with headquarters at Easton, Pa. The following year he was transferred to Orlando, Fla., as general manager of the Florida Public Service Company. In 1929 he was made general manager of the Broad River Power Company, now South Carolina Electric and Gas Company, and in 1930 became vice-president. He was appointed vice-president also of the Lexington Water Power Company, of which he is now president.

C. M. Jansky (A'06, F'32) has retired as professor of electrical engineering, University of Wisconsin, Madison. He was born March 15, 1870, at Bloom, Wis., and received the degree of bachelor of arts from Valparaiso University in 1893, and that of bachelor of science in electrical engineering from the University of Michigan in 1904. After ten years of public-school teaching at Ausable, Mich., he became an assistant in physics at the University of Michigan, Ann Arbor, while securing his second degree. He was a research assistant at the National Bureau of Standards, Washington, D. C., 1904–05, and in 1905 became professor of physics and electrical engineering at the University of Oklahoma, Norman, where he headed the engineering department. He went to the University of Wisconsin as assistant professor in 1908, later becoming associate professor and full professor. He is the author of several books and a number of technical articles, and is also a member of Sigma Xi, the American Association for the Advancement of Science, the Society for the Promotion of Engineering Education, and the Society of Mathematicians and Physicists of Czechoslovakia.

F. J. Scudder (M'25) co-author with John N. Reynolds of the paper "Crossbar Dial Telephone Switching System" has received the 1939 AIEE national prize award for best paper in engineering practice. Born at

F. J. SCUDDER

W. C. JOHNSON

F. C. HOLTZ

Norwalk, Conn., June 2, 1884, and educated there, Mr. Scudder received his technical education through correspondence courses. He entered the employ of the New York (N. Y.) Telephone Company in 1905, on central office maintenance, becoming central office wire chief in 1908. In 1910 he was appointed equipment engineer and detailed to study semimechanical systems then under development by Western Electric Company. He was transferred to the technical staff of Western Electric in 1918, and when Bell Telephone Laboratories was formed continued on the technical staff of that organization. For some years he has been systems development engineer responsible for circuit development and economic studies relating especially to expansion of dial systems and for circuit design associated with the commercial application of such developments.

F. C. Holtz (A'16, M'25) has received the 1939 AIEE national prize award for best paper in theory and research for his paper on "The Anomalous Behavior of the Moving Systems of Single-Phase A-C Watt-Hour Meters at No Load". He was born at Wahoo, Nebr., May 6, 1888, and received the degree of bachelor of science in electrical engineering from the University of Nebraska in 1913. He spent the next three years with General Electric Company, Schenectady, N. Y., in the testing and consulting engineering departments, returning to the University of Nebraska, Lincoln, in 1916 as instructor in electrical engineering. Following army service during 1917–18, he became chief engineer of the Sangamo Electric Company, Springfield, Ill., later becoming vice-president. He has continued with the company in those capacities ever since.

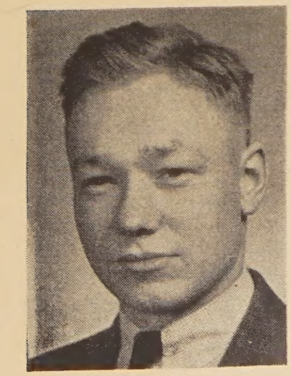
W. C. Johnson (A'35) has received the 1939 AIEE national prize award for initial paper for his paper "Predetermination of Temperatures in Resistance Welds". Born January 6, 1913, at Weikert, Pa., he received the degree of bachelor of science in electrical engineering from Pennsylvania State College in 1934. Following graduation, he was employed by General Electric Company, Schenectady, N. Y., as a student engineer. After a year in the testing department he was transferred to the engineering department, where he continued until 1937, and during this period completed the three-year advanced course in engineering offered by the company. In 1937 he became an instructor in electrical engineering at Princeton University, Princeton, N. J., and recently was advanced to assistant professor. He is also a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

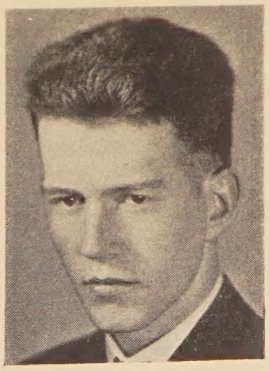
E. C. Dench (Enrolled Student) Massachusetts Institute of Technology, Cambridge, has received the 1939 AIEE national prize award for Branch paper for his paper on "The 'Glo-Relay', a New Method of Initiating Vapor Discharges". He has also received the AIEE District 1 prize award for best Branch paper for 1938–39. Both prizes were awarded jointly for this paper and one by W. N. Brown, Jr., and E. W. Sheridan (Enrolled Students). Mr. Dench was born at East Orange, N. J., July 12, 1916, and received the degree of bachelor of science at Worcester Polytechnic Institute in 1939 and that of master of science at Massachusetts Institute of Technology in 1940. The prize-winning paper was written while he was a student at Worcester Institute, where he held a Westinghouse Memorial scholarship. During 1939–40 he held a Tau Beta Pi fellowship for graduate study at MIT. Before entering college and during several vacations he was employed at the Westinghouse Lamp Division, Bloomfield, N. J. He is also a member of Sigma Xi.

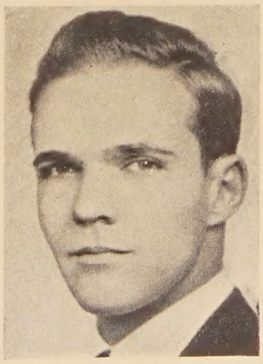
W. N. Brown, Jr. (Enrolled Student) Massachusetts Institute of Technology, Cambridge, co-author with E. W. Sheridan (Enrolled Student) of the paper "Frequency-Selective Feedback for Improvement of Acoustical Response of an Audio-Frequency Sound System", has received the 1939 AIEE national prize award for Branch paper. He has also received the AIEE District 1 prize award for best Branch paper for 1938–39. Both prizes were awarded jointly for this paper and one by E. C. Dench (Enrolled Student). Mr. Brown was born at Washington, D. C., November 16, 1917, and is studying electrical engineering in the five-year co-operative course at MIT, having had eight months of co-operative work at the General Electric Company. He has been vice-chairman of the MIT Student Branch and is also a member of Sigma Xi and a student member of the Institute of Radio Engineers.

E. W. Sheridan (Enrolled Student) Massachusetts Institute of Technology, Cambridge, co-author with W. N. Brown, Jr. (Enrolled Student) of the paper "Frequency-Selective Feedback for Improvement of Acoustical Response of an Audio-Frequency Sound System", has received the 1939 AIEE national prize award for Branch paper. He has also received the AIEE District 1 prize award for best Branch paper for 1938–39. Both prizes were awarded jointly for this paper and one by E. C. Dench (Enrolled Student). Mr. Sheridan was born April 25, 1917, at Malden, Mass., and is studying electrical engineering at Massachusetts Institute of Technology.

H. A. Affel (A'18, M'23) with co-author B. W. Kendall (M'18, F'29) has received honorable mention in the 1939 AIEE national prize award for best paper in engineering practice for their paper "A 12-Channel Carrier Telephone System for Open-Wire Lines". Born at Brooklyn, N. Y., August 4, 1893, Mr. Affel received the degree of bachelor of science at Massachusetts Institute of Technology in 1914. From 1914 to 1916 he was a research assistant in the electrical-engineering department at MIT, Cambridge, and in 1916 he went with the American Telephone and Telegraph Company, New York, N. Y. After three years in the engineering department, he was transferred to the department of development and research, and in 1934 he was transferred to Bell Telephone Laboratories, where he is at present assistant director of transmission development. He also received honorable mention for best paper in engineering practice in the AIEE national prize awards for 1934, and recently was honored by the National Association of Manufacturers as a "modern pioneer".


W. N. BROWN, JR.


E. W. SHERIDAN


E. C. DENCH

B. W. Kendall (M'18, F'29) with co-author **H. A. Affel** (A'18, M'23) has received honorable mention in the 1939 AIEE national prize award for best paper in engineering practice, for their paper "A 12-Channel Carrier Telephone System for Open-Wire Lines". Mr. Kendall was born November 1, 1883, at Gardner, Mass., and received the degree of bachelor of science from Massachusetts Institute of Technology in 1906, later carrying on graduate study in physics at Columbia University. He was an assistant in the department of physics at MIT, Cambridge, 1906–08, and at Barnard College, New York, N. Y., 1909–11, and instructor in physics at Columbia, 1911–13. In 1913 he entered the research laboratory of Western Electric Company, and in 1919 was placed in charge of toll development. He continued in this capacity at Bell Telephone Laboratories, and recently became director of circuit research. He was awarded honorable mention in the 1933 AIEE national prize award for best paper in theory and research.

A. H. Howell (A'35) has received honorable mention in the 1939 AIEE national prize award for initial paper for his paper "Breakdown Studies in Compressed Gases". Born February 5, 1908, at Sedgwick, Kans., he received the degrees of bachelor of science in electrical engineering, University of Kansas, 1929; and master of science in electrical engineering, Michigan College of Mining and Technology, 1934; and doctor of science, Massachusetts Institute of Technology, 1938. During 1929–30 he was a student engineer in the test course at General Electric Company, Schenectady, N. Y., at the same time studying at Union College. In 1931 he became an instructor in electrical engineering at Michigan College of Mining and Technology, Houghton, and in 1934 left that position on leave of absence to continue graduate study at Massachusetts Institute of Technology, Cambridge. In 1936 he was awarded a Charles A. Coffin Foundation fellowship. Since 1938 he has been a research assistant at MIT.

Irven Travis (A'32, M'40) has received honorable mention in the 1939 AIEE national prize award for best paper in theory and research for his paper "Subharmonics in Circuits Containing Iron-Cored Inductors—II". Born March 30, 1904, at McConnelsville, Ohio, he received the degrees of bachelor of science in electrical engineering, 1926, Drexel Institute of Technology; master of science in electrical engineering, 1928, and doctor of science, 1938, University of Pennsylvania. He was employed on toll-cable engineering by the Bell Telephone Company of Pennsylvania, 1926–28. In 1928 he became an instructor in electrical engineering at the Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, and in 1935 became assistant professor. He has also carried on consulting practice for RCA Victor and General Electric Company. He is also a member of the Society for the Promotion of Engineering Education.

C. R. Davis (A'36) has received honorable mention in the 1939 AIEE national prize award for initial paper for his paper "Signal System, Interlocking Plants, and Automatic Train Control on the San Francisco-Oakland Bay Bridge Railway". Born November 26, 1889, at Valley, Nebr., and educated there, he received his technical training by correspondence. He was in the service of the United States Navy 1907–11, and after two years in the employ of the San Diego (Calif.) Electric Railways, returned to the Navy Department service as ship draftsman, continuing with this work and as warrant carpenter until 1922. He was a mechanical engineer for Link-Belt, Meese and Gottfried Company, San Francisco, Calif., 1922–27, and since 1928 has been in the employ of the State of California, first as junior bridge designing engineer in the department of highways, and since 1931 in charge of electrical work on the San Francisco-Oakland Bay Bridge project.

H. E. Warren (A'02) has received honorable mention in the 1939 AIEE national prize award for best paper in theory and research for his paper "A New Time Standard". Born May 21, 1872, at Boston, Mass., he received the degree of bachelor of science at Massachusetts Institute of Technology in 1894. From 1897 to 1902 he served as engineer for the Saginaw Valley Traction Company, Saginaw, Mich., and from 1902 to 1918 as superintendent and as consulting engineer of the Lombard Governor Company, Boston, Mass. For more than 25 years he has been concerned with the development of electric clocks, first utilizing alternating current for purposes of timekeeping in 1916. He has been president of the Warren Telechron Company, Ashland, Mass., since about 1920. He was awarded the 1934 AIEE Lamme Medal, and in 1935 received the John Price Wetherill Medal of the Franklin Institute. He was recently honored by the National Association of Manufacturers as a "modern pioneer".

E. L. Harder (A'30) has received honorable mention in the AIEE 1939 national prize award for best paper in engineering practice for his paper "Pennsylvania Railroad, New York-Washington-Harrisburg Electrification, Relay Protection of Power Supply System". Born April 28, 1905, at Buffalo, N. Y., he received the degree of electrical engineer from Cornell University in 1926. Immediately after graduation he entered the student course of The Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa. In 1927 he was transferred to the power engineering department and the next year to the general engineering department. He has continued with the company in various capacities, and is at present central-stations engineer.

A. M. Wright (A'27) assistant engineer, electrical department, the Reading Company, Philadelphia, Pa., has been presented with a 1940 Commemoration Medal by the New Zealand Institution of Engineers for his paper on "Modern Rail Transport". The paper was prepared for presentation at the proposed centennial Engineering Congress, which was cancelled on account of the war in Europe. Mr. Wright is a native (1901) of New Zealand, received the degree of master of science from the University of New Zealand in 1922, and was then employed for two years by Trumbull and Jones, electrical engineers, Wellington. He entered the student course at Westinghouse Electric and Manufacturing Company in 1924, later being transferred to the railway-engineering department. Since 1929 he has been with the Reading Company.

W. B. Bedell (A'35, M'35) formerly an equipment engineer in the long-lines engineering department of the American Telephone and Telegraph Company, New York, N. Y., has been transferred to Chicago, Ill., as district plant engineer in the long-lines division.

E. F. De Turk (A'24, M'30) formerly transmission and distribution superintendent, Metropolitan Edison Company, Reading, Pa., has been employed as electrical engineer by the Long Island Lighting Company, Mineola, N. Y.

W. D. Hull (A'39) formerly head of the electrical department, Steuben County Farm Bureau Co-operative Association, Angola, Ind., is now employed by the Indiana Service Corporation, Fort Wayne.

W. T. Hannum (A'39) has been transferred by the Pacific Gas and Electric Company from the position of assistant engineer in line construction at San Francisco to that of division superintendent of the Coast Valleys division.

Wilbur Roadhouse (A'21) engineer of the plant results section, American Telephone and Telegraph Company, New York, N. Y., has been transferred to the plant employment section, plant operation division.

A. R. Small (M'37) president, Underwriters Laboratories, Chicago, Ill., has been nominated president of the National Fire Protection Association for 1940–41. He is now serving as vice-president of the Association.

A. W. Staller (A'29) factory manager, Crescent Insulated Wire Cable Company, Trenton, N. J., has been nominated a director of the Engineers Club of Trenton for 1940–41.

A. J. Hendry (A'39) formerly engineering aide with the Works Progress Administration, Detroit Lakes, Minn., has been employed as an electrical engineer by the Iowa Public Service Company, Waterloo.

Obituary • • •

George Gibbs (A'05, M'05, F'12) president, Gibbs and Hill, consulting engineers, New York, N. Y., died May 20, 1940. He was born at Chicago, Ill., April 19, 1861, and received the degree of mechanical engineer in 1882 and that of doctor of engineering in 1930 from Stevens Institute of Technology. After two years as chemist for the Orford Copper Company, he went with the Chicago, Milwaukee, and St. Paul Railroad in 1884, as engineer of tests and chemist, and from 1888 to 1897 was mechanical engineer for the road, during which period he developed a system of electric lighting for passenger trains. He was also consulting engineer for the Illinois Steel Company. In 1897 he became consulting engineer for the Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company, and chief engineer of the British and the Continental Westinghouse companies. In 1901 he became first vice-president of the firm of Westinghouse, Church, Kerr, and Company, New York, at the same time being consulting engineer for the Interborough Rapid Transit Company, New York; a member of the board of engineers of the Pennsylvania Terminal; member of the electric traction commission of the New York Central Railroad; and electrical engineer, Long Island Railroad. From 1905 he was chief engineer in charge of the design and construction of Pennsylvania Station and of electric traction for the Pennsylvania Railroad Company. After completion of the station he continued as consulting electrical engineer for the Pennsylvania Railroad and chief engineer of electric traction for the Long Island Railroad. He was a member of the advisory commission of railway experts sent to Russia in 1917 by the United States Government, and was a former member of the New York State Transit Commission. He was the inventor of many railway appliances, notably the first all-steel passenger car, which was adopted by the Interborough Rapid Transit System and later by the Pennsylvania and Long Island Railroads. He was also a member of the American Society of Civil Engineers, which awarded him the Norman Medal, 1911, and the Wellington Prize, 1930, and of The American Society of Mechanical Engineers, American Association for the Advancement of Science, Institution of Civil Engineers of Great Britain, and of several railway organizations, and a past president of the American Institute of Consulting Engineers.

Roger Thomas Smith (M'19) consulting engineer, partner of firm of Highfield and Roger Smith, London, England, died April 28, 1940. He was born in London in 1863, and studied mechanical and electrical engineering at the University of London, receiving the degree of bachelor of science. From 1886 to 1890 he was an apprentice with Hathorn, Davey, and Company, Leeds, makers of pumping machinery, and from 1890 to 1893 was engaged in installing pumping machinery in India as engineer for Easton, Anderson and Goolden, Ltd. He was employed as a resident engineer by the Westminster Electrical Supply Corporation, 1894–95, and as manager for the Imperial Continental Gas Association, supplying hydraulic and electric power to Antwerp, Belgium, 1895–98. From 1898 to 1905 he was a member of the staff of Sir Alex. Kennedy, consulting engineer, and in 1905 he became electrical engineer for the Great Western Railway. He continued in that position about 20 years, then becoming a partner in the consulting firm with which he was associated at the time of his death. He was a past president of the Institution of Electrical Engineers and a member of the Institutions of Civil and Mechanical Engineers, all of Great Britain, and had served as a delegate to the International Electrotechnical Commission.

Arthur D. Stephanus (M'28) assistant to European vice-president, Westinghouse Electric International Company, London, England, died January 3, 1940. He was born in Ohligs, Germany, November 1, 1883, and graduated in law at the University of Kiel and Gottengen. In 1909 he entered the employ of the Westinghouse Electric and Manufacturing Company as a clerk in the accounting department of the East Pittsburgh, Pa., works. In 1911 he was made a correspondent in the industrial and power section and in the export department. He was export representative of the company at the Panama Pacific Exposition, San Francisco, Calif., 1915, and the same year was placed in charge of European negotiations in the export department. In 1919 he went to Norway as a special representative of Westinghouse, becoming head of the power and railway department there. He was placed in charge of London engineering negotiations in 1922, and the following year returned to Norway as London representative for the Scandinavian countries. He had been assistant to the European vice-president since 1931.

Norman Crawford McPherson (A'03) retired consulting engineer, died October 15, 1939, at Short Hills, N. J., according to information just received at Institute headquarters. He was born May 29, 1869, at Gettysburg, Pa., and attended Pennsylvania College and Johns Hopkins University, studying electrical engineering at the latter. He was employed by the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., spending three years as a shop assistant and two years as salesman and engineer before becoming engineer and assistant to the manager of the general manufacturing department. He was later transferred to the engineering staff of Westinghouse, Church, Kerr and Company, New York, N. Y., where he continued for more than ten years, setting up his own consulting practice about 1920. Later he became consulting engineer on railway electrification for S. E. Junkins Company, B. C., Ltd., Vancouver, B. C., Can., and consultant on railway terminals for Edward J. Noonan, Chicago, Ill. He retired about three years ago.

Virginius Daniel Moody (A'99, M'11, F'12) president, Moody Engineering Company, New York, N. Y., died May 30, 1940. He was born February 5, 1878, at Norfolk, Va., and received the degree of mechanical engineer in electrical engineering from Cornell University in 1900. In 1901 he entered the student engineering course at General Electric Company, Schenectady, N. Y., and in 1903 was transferred to the foreign engineering department. In 1905 he was employed as an electrical engineer by F. S. Pearson, consulting engineer, where he had charge of electrical installations in Canada, Mexico, and Brazil. He was employed as assistant engineer on the East River tunnels of the Interborough Rapid Transit Company, New York, N. Y., 1907–08. In 1908 the firm of Hanmer and Moody was formed to engage in general engineering work, and in this capacity Mr. Moody continued to serve as electrical engineer for the Pearson interests in Latin America. The Moody Engineering Company, of which he was president, was formed in 1917.

Frederic Kirk Knowlton (M'25) vice-president and managing director of M. D. Knowlton Company and Auburn Ball Bearing Company, Rochester, N. Y., died in December 1939, according to information just received at Institute headquarters. He was born February 23, 1879, at Chicago, Ill., and received his technical education at Rochester Mechanics Institute, Purdue University, where he studied mechanical engineering, and Columbia University, where he studied electrical engineering. During 1900 he was with the Mexican Petroleum Company, Ebeno, Mex., and the following year became managing director of the Knowlton and Auburn companies, manufacturing paper-package machinery. He served in the ordnance department of the United States Army during the World War, and was a lieutenant-colonel in the Officers Reserve Corps. He was also a member of The American Society of Mechanical Engineers.

Herman Henry Sticht (A'13, M'28) manager and member of the firm of Herman H. Sticht and Company, New York, N. Y., died February 11, 1940. He was born November 5, 1889, at Brooklyn, N. Y., and graduated in electrical engineering at Cooper Union Technical Day School in 1908. During the next two years he was employed by the Electrical Testing Laboratories, New York, N. Y., as technical assistant, and from 1910 to 1912 was assistant in charge of small appliances for the New York office of Siemens and Halske, Berlin firm. In 1912 he became a sales engineer for James G. Biddle, Philadelphia, Pa., having charge of the company's New York office, and continued in this position until the formation of Herman H. Sticht and Company, electrical and industrial instrument engineers, in 1918. The company, of which he was manager, acted as American representatives of several German and Swiss firms.

Edward James Barry (A'10, M'29) consulting electrical engineer, Tacoma, Wash., died March 4, 1940. He was born May 30, 1882, at Glasgow, Scotland, and received the degree of electrical engineer from Glasgow and West of Scotland College in 1906. He was employed in the electricity department of the Greenock Corporation, Greenock, Scotland, and on coming to the United States entered the employ of the Washington Water Power Company, Spokane, in 1909. The following year he was employed by the Potlatch Lumber Company, Potlatch, Idaho, on the electrification of lumber mills, and in 1912–13 was engaged in the electrification of the St. Paul and Tacoma Lumber Company, Tacoma, Wash. In 1913 he started private consulting practice in Tacoma, specializing in industrial power and lighting, principally in the lumber industry, but also for mining and pulp and paper companies and others.

Sheldon Roberts (A'25) electrician, Columbus and Southern Ohio Electric Company, Columbus, Ohio, died April 21, 1940. He was born November 3, 1872, at Columbus, and educated there. From 1903 to 1914 he was employed by the Columbus Railway and Light Company on plant and distribution work. He was an appraisal engineer for the Ohio State Public Utilities Commission 1915–16, and during the next two years was engaged on construction work on industrial plants, and in 1919 was employed on plant construction and maintenance by the Columbus Railway, Light, and Power Company. He later became electrician, which position he continued to hold after the consolidation of the Columbus and Southern Ohio companies.

Lewis C. Halpin (A'26) assistant superintendent, Niagara, Lockport, and Ontario Power Company, Buffalo, N. Y., died December 11, 1939. He was born September 19, 1898, at Rochester, N. Y., and graduated in electrical engineering from Tri-State College. From 1917 to 1921 he was employed by the Niagara, Lockport, and Ontario company as operator and system operator. In 1923 he became general construction foreman for the New York Power and Light Company, and the next year was made assistant electrical superintendent of the Glens Falls district. He returned to the Niagara, Lockport, and Ontario company in 1928 as superintendent of meters, western division; in 1931 became rural engineer and supervisor of substation construction, Angola division; and later became distribution engineer, and finally assistant superintendent.

Oswald Stickney (A'32) relay test man, Detroit Edison Company, Detroit, Mich., died April 29, 1940. He was born September 13, 1901, at Newburgh, N. Y., and received the degree of bachelor of science in electrical engineering from Detroit Institute of Technology in 1931. He entered the employ of the Detroit Edison Company in 1920 as construction journeyman's helper, being transferred to the electrical maintenance department in 1922 and to the operating department in 1923. He became an operator in the substations department the same year, and in 1926 was transferred to the automatic division and later promoted to foreman operator. He was also a member of the Engineering Society of Detroit.

Edward Robertson Pennell (A'34) chief of design department, Hewittic Electric Company, Ltd., Walton-on-Thames, England, died recently, according to information just received at Institute headquarters. He was born in 1898 at Liverpool, England, and received the diploma in electrical engineering of the Polytechnic, London, in 1922. From 1923 to 1925 he was employed by the British Thomson-Houston Company, Rugby, chiefly on tests. He had been with the Hewittic Electric Company since 1925, first as engineer of the technical department, then as member and finally chief of the design staff. He was also a member of the Institution of Electrical Engineers of Great Britain.

William Wesley Winter (A'38) sales engineer, Allis-Chalmers Manufacturing Company, Chicago, Ill., died December 11, 1939. He was born April 8, 1916, at Chicago, and received the degree of bachelor of science in electrical engineering at Purdue University in 1937. Immediately after graduation he entered the student engineering course of Allis-Chalmers, at West Allis, Wis., and was transferred to the Chicago office as sales engineer in 1939.

Membership • •

Recommended for Transfer

The board of examiners, at its meeting on June 13, 1940, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Coit, N. H., president, South Carolina Electric and Gas Company, Columbia.
David, B. W., wire relations engineer, Cleveland Electric Illuminating Company, Cleveland, Ohio.
Luckiesh, M., director, lighting research laboratory, General Electric Company, Cleveland Ohio.
Trueblood, H. M., protection development director, Bell Telephone Laboratories, New York, N. Y.
Wagner, C. F., consulting transmission engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Weber, H. H., engineer, United States Rubber Company, New York, N. Y.

6 to Grade of Fellow

To Grade of Member

Avtzine, A. D., engineer, Canadian and General Finance Company, Ltd., Toronto, Ont.
Cover, L. G., assistant manager, Cleveland Wire Works, General Electric Company, Euclid, Ohio.
Creese, Myron, professor and head of department of electrical engineering, University of Maryland, College Park.
DeLeau, L. H., assistant engineer, Brooklyn Edison Company, Brooklyn, N. Y.
DeMonte, R. W., member of technical staff, Bell Telephone Laboratories, New York, N. Y.
Farrar, C. L., associate professor of electrical engineering, University of Oklahoma, Norman.
Gates, H. S., section engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Gutzwiller, W. E., sales engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Hague, A. E., electrical engineer, Bell Telephone Laboratories, New York, N. Y.
Harper, J. D., electrical engineer, Aluminum Company of America, Alcoa, Tenn.
Helgason, A., executive vice-president, Chicago Transformer Corporation, Chicago, Ill.
Hoefflin, A. S., personnel director, Louisville Gas and Electric Company, Louisville, Ky.
Kruesi, P. J., president and general manager, Southern Ferro Alloys Company, and American Lava Corporation, Chattanooga, Tenn.
Lindstron, H. L., electrical engineer, Dravo Corporation, Pittsburgh, Pa.
Mabson, E. B., division engineer, Louisville Power and Light Company, New Orleans, La.
Monteith, A. C., manager, central station engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Montgomery, L. M., Shawnee district engineer, Oklahoma Gas and Electric Company, Shawnee.
Pickett, G. E., assistant operating engineer, Carolina Power and Light Company, Raleigh, N. C.
Plank, W. L., electrical engineer, Pennsylvania Turnpike Commission, Harrisburg, Pa.
Ross, P. M., superintendent of high-voltage laboratories, Ohio Brass Company, Barberton.
Tritle, J. F., engineer, General Electric Company, Erie, Pa.

21 to Grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical Districts. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before July 31, 1940, or September 30, 1940, if the applicant resides outside of the United States or Canada.

United States and Canada

1. NORTH EASTERN

Bivens, M. E., General Electric Company, Schenectady, N. Y.
Harrer, J. M., New York State Public Service Commission, Albany, N. Y.
Martin, A., Southern New England Telephone Company, New Haven, Conn.
Tuthill, H. E., New York State Electric and Gas Corporation, Plattsburg, N. Y.

2. MIDDLE EASTERN

Abbott, W. R., Leeds and Northrup Company, Philadelphia, Pa.
Barbulesco, C. D. (Member), Antioch College, Yellow Springs, Ohio.
Buus, B. R., General Electric Company, Cleveland, Ohio.
Duquette, J. F. (Member), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Hart, J. V., Brown Instrument Company, Philadelphia, Pa.
Laird, J. S., Koppers Coal Company, Pittsburgh, Pa.
Ryder, J. D., Bailey Meter Company, Cleveland, Ohio.
Tarzian, V., 3004 North Howard Street, Philadelphia, Pa.
Weeks, J. R., Westinghouse Electric and Manufacturing Company, Mansfield, Ohio.
Zimmer, A. A., Rowan Controller Company, Baltimore, Md.

3. NEW YORK CITY

Doughty, G. F. (Member), Simplex Wire and Cable Company, New York, N. Y.
Falck, E., Consolidated Edison Company of New York, Inc., New York, N. Y.
Jatlow, J. L. (Member), Photo Positive Corporation, Shoreham, Long Island, N. Y.
Johnson, R. M., A Company, 51st Signal Battalion, Fort Monmouth, Oceanport, N. J.
Haaland, I., Brooklyn-Queens Transit Company, Brooklyn, N. Y.
Moore, F. A., Public Service Electric and Gas Company, Passaic, N. J.
Rentschler, H. C. (Member), Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.
Scher, V. A., care of Richards and Geier, New York, N. Y.

4. SOUTHERN

Beal, J. A., Memphis Light Gas and Water Division, Memphis, Tenn.
Booth, C. V., Florida Power and Light Company, Miami Beach.
Love, G. A., Robert and Company, Atlanta, Ga.
Schindler, L. J., Jr., 622 Drew Street, Lake Charles, La.

5. GREAT LAKES

Brede, E. F., 18900 Warrington Drive, Detroit, Mich.
Fox, H. N. (Member), Commonwealth and Southern Corporation, Jackson, Mich.
Gilborne, S. S., Jr., Aermotor Company, Chicago, Ill.
Unger, A. M., Pullman Standard Car Manufacturing Company, Chicago, Ill.
Miller, E. F., Peoples Power Company, Moline, Ill.
Schafer, V. E., Jr., General Motors Corporation, Detroit, Mich.

7. SOUTH WEST

Bayless, W. T., Black and Veatch, Kansas City, Mo.
Richardson, A. I. (Member), Allis Chalmers Manufacturing Company, Dallas, Tex.
Smith, P. deW., Pennsylvania Shipyards, Inc., Beaumont, Tex.
Stahl, C. R. (Member), Panhandle Power and Light Company, Borger, Tex.
Wilson, C. W., Electric Storage Battery Company, Dallas, Tex.

8. PACIFIC

Bush, J. E., Parker Electric Light Plant, Parker, Ariz.
Campini, E. J., Market Street Railway Company, San Francisco, Calif.
Carlson, R. L., Southern California Edison Company, Ltd., Alhambra, Calif.
Haack, V. L., Pacific Gas and Electric Company, San Francisco, Calif.
Moody, A. W., General Electric Company, San Francisco, Calif.

9. NORTH WEST

MacPherson, R. M., Wagner Electric Corporation, Portland, Ore.
Mushlitz, A. R. (Member), Clearwater Valley Light and Power Association, Inc., Lewiston, Idaho.
Perry, R. T. (Member), Bonneville Project, Portland, Ore.
Pound, J. C., Corps of Engineers, United States Army, Bonneville, Ore.
Talbott, A. L., Washington Water Power Company, Spokane.

Total, United States and Canada, 47

Elsewhere

De, A. C., 6/1 Kanklia Road, Ballygunge, Calcutta, India.
Feinberg, R. (Fellow), University of Manchester, Manchester, England.
Pinheiro, H., Pindamonhangaba, Estado S. Paulo, Brazil.

Total, elsewhere, 3